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# Low Emission Zones in Europe

## for ADEME




## Final report

## Sadler Consultants

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## 1. Introduction

Low Emission Zones (LEZs) are geographic areas where entry is limited to the more polluting vehicles, aimed at improving air quality. LEZs were first introduced in 1996 in Sweden - Stockholm, then Gothenburg and Malmo, to improve air quality. In 2005, the north Italian regions made an agreement together to implement air quality measures, which led to winter LEZs in those regions. In January 2007, a 'motorway LEZ' was introduced in Austria. In July 2007 LEZs started operating in the Netherlands and since then, the number planned has been increasing almost monthly[1]. There is already one LEZ on French soil, on the Mont Blanc road tunnel between France and Italy. There are now over 225 LEZs in operation or concrete planning, in 11 countries in Europe.

LEZs are implemented to help meet the EU $PM_{10}$ and $NO_2$ Limit Values. LEZs are required to be at least considered when applying for extensions to the EU air quality Limit Values. Noise, traffic reduction and $CO_2$ are sometimes secondary aspects, but are not expected to change significantly with most LEZs. LEZs have a potential climate change benefit by reducing black carbon (all PM reduced by LEZs is black carbon).

There are many models of LEZs around Europe, depending on the air quality, vehicle fleet and economic situation, country culture and other factors. Most LEZs are aimed at heavy-duty vehicles (HDVs), are in permanent operation, and allow vehicles to meet the set standards by the retrofitting of diesel particulate filters (DPFs). But this is not always the case, as there are LEZs affecting all vehicles, that are time-limited, that do not allow retrofitting, that allow $NO_x$ retrofitting, or that charge for entry as opposed to banning vehicles.

Most LEZs have also been introduced in stages, starting often with a weaker standard (for example Euro 2), and increasing as time moves on in order to have a larger emissions impact. Table 1 gives an overview of LEZs by country, including whether they have national or regional frameworks. Table 1 in Annex 1 (to enable ease of reading for this report) gives an overview table of all LEZs, including the start dates, vehicles, emissions standards and whether they allow retrofit.

**Table 1. LEZs by country and framework type**

| Country | Framework | Vehicle type | Emissions standard 2011 | Future standard |
|---|---|---|---|---|
| **Austria** | Individual * | Lorries only | Autobahn A12 | Euro 2/3 |
| **Denmark** | National | Heavy duty vehicles >3.5T | fit Filter if less than Euro 4 | Potentially stronger and including vans |
| **Germany** | National | Vehicles with 4+ wheels | Euro 2-4 (PM) & Euro 1 Petrol | Euro 3-4 (PM) & Euro 1 Petrol |
| **Italy** | Regional | All vehicles | Euro 1-4 / no 2-stroke motorcycles | Euro 2-4 / no 2-stroke motorcycles |
| **London, UK** | Individual | Heavy duty vehicles >3.5T | Euro 3 (PM) | Euro 4 (PM) (3/1/12) |
| **London, UK** | Individual | Vans | None | Euro 3 (3/1/12) |
| **Mont Blanc Tunnel, FR/IT** | Individual | Lorries only | Euro 1 | |
| **Netherlands** | National | Lorries only | Euro 4 (PM) | Euro 4 (1/7/13) |
| **Norwich, UK** | Individual | Local buses under agreements | Euro 3 (NOx) | |
| **Oxford, UK** | Individual | Local buses under agreements | None | Euro V (1/1/14) |
| **Prague, CZ** | Individual | Heavy duty vehicles >3.5T | Euro 2 | |
| **Sweden** | National | Heavy duty vehicles >3.5T | 8 years old / Euro 3 | |

* national scheme in preparation

In addition to the LEZs in operation, there are a number of other countries that have considered or are at early stages of planning LEZs.

1see http://www.lowemissionzones.eu/emission-standards-table/-by-start-date-othermenu-46 for the LEZs by date of introduction.

- Switzerland also prepared a draft national LEZ scheme in 2010, on the request of three Kantons, but then a vote of all the Kantons in 2011 decided not to introduce it.
- Norway is planning a national LEZ framework, but this is at early stages. The current Norwegian consideration is charging for non-Euro 6 heavy goods vehicles, building on the Autopass motorway tolling system[2].
- The Czech Environment Ministry has taken a law to parliament, with an amendment that would allow Czech cities to set up LEZs. The LEZ aspect has been rejected, but the Environment Ministry plans to work on it and re-submit it.
- In Spain, Madrid has done a feasibility study on LEZs, but nothing has as yet been taken forward.

### 1.1. Types of LEZ

There are several types of LEZ, the 'main categories' are:

- Those that ban vehicles from entering an area of a town (most LEZs)
- Those that charge polluting vehicles more to enter an area (eg Milan Ecopass) or road section (Mont Blanc tunnel)
- Motorway or key road LEZ (Austria and Mont Blanc tunnel)
- Those that in practice ban vehicles, but are operated by charging a very high daily entrance fee (London)

There are very few LEZs affecting motorways, due to issues with the EU law on freedom of movement (see section 2).

Another distinction for most countries is whether the LEZs are under criminal or civil law. However, all French traffic offences operate under criminal or administrative law, but the difference as in other countries is given here. Using criminal law tends to require manual enforcement with police and can enable penalties such as a point on the drivers licence. Using civil law tends to enable camera and traffic warden (or similar non-police staff) enforcement without stopping the traffic. Camera enforcement can achieve higher compliance rates and can be cheaper in the long run when large numbers of vehicles are involved.

### 1.2. Overview of the existing LEZs

All countries with LEZs in operation have national frameworks, with the exception of the UK and Italy. The Swedish LEZs started without a national framework, but now operate within one. This section gives an overview of the existing national frameworks in operation.

#### 1.2.1. Austria

The national ministry is preparing an LEZ law. However, there is a motorway LEZ in operation on the A12 in Tyrol. Motorway LEZs are not usually allowed, but this case was allowed by the EU - more details in section 2. The current standards are set as the $NO_x$ aspect of Euro 2.

#### 1.2.2. Denmark

Denmark has had a national scheme for LEZs in place since September 2008. The LEZ affects HDVs over 3.5T, the standards set were:

After 1 July 2008

- Vehicles over 7 years old must fit a diesel particulate filter (DPF) (the DPF must be certified, and achieve 80% PM reduction. The 80% PM reduction is equivalent to moving from Euro 3 to Euro 4)

2AutoPASS is an electronic payment system for motorways in Norway. The is an electronic device purchased and placed in the vehicle. Each time you pass through a toll station the fee is deducted from your account. AutoPASS devices are obtained by signing an agreement with one of the toll operators in Norway, and paying a deposit.

- Or meet Euro 3 (PM)

After 1 July 2010

- Vehicles over 4 years old must fit DPF
- Or meet Euro 4 (PM)

The national LEZ law was changed in 2010 to allow cities to strengthen the LEZs and also include vans in the restrictions. As of May 2011 no Danish city has yet announced such strengthening of the standards. The standards phrased in terms of Euro 3 or fit a DPF focuses the LEZ more on PM than other LEZs, however the outcome is not likely to be so different to setting a standard of Euro 3(PM), where the same compliance options are possible in practice. The significant aspect of the Danish scheme is the effective requirement for full filters.

### 1.2.3. Germany

A national framework for LEZs sets standards and vehicles to be affected (see table below) and cities/Länder [Federal regions] choose what, whether and when to implement which 'colour' LEZ. All vehicles, except motorcycles, must have the appropriate coloured sticker in the windscreen to access the LEZ.

Most German LEZs have started on 'red stickers', and then tightened or planning tightening. Some, later LEZs such as Leipzig have started on 'green stickers'. A few, such as Munich, are still on red stickers, but considering tightening.

**Table 2. German LEZ emissions standards**

| Emissions class | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Sticker | No Sticker |   |   |   |
| Requirement for diesel vehicles | Euro 1 or worse | Euro2 or Euro1 particulate filter | Euro3 or Euro2 particulate filter | Euro4 or Euro3 particulate filter |
| Requirement for petrol vehicles | Without a catalytic converter | | | Euro1 with catalytic converter or better |

### 1.2.4. France

The LEZ currently operating on French soil is the non-typical LEZ through the Mont Blanc road tunnel between France and Italy. Euro 0 lorries are banned, and Euro 1 lorries cost more than other Euro standards.

### 1.2.5. Italy

LEZs started in Italy with the northern Italian regions of Lombardia, Piemonte, Bolzano, Emilia Romagna, Trento and Umbria having a regional agreement that requires air pollution measures to be undertaken towards meeting the EU air quality Limit Values (LVs). The agreement is like a regional 'do-minimum' action plan, and the air quality measures include LEZs, financial assistance for cleaner vehicles, better public transport, wood burning restrictions etc. There are also increasing numbers of other Italian regions implementing LEZs. In general, all vehicles under 3.5T are affected, including two-stroke motorcycles. Each region has similar schemes, but details and standards vary, as does the level of coordination by the regional authority (from defining the details of the LEZ to requiring LEZs to be at least a certain standard).

Emissions standards are generally low, around Euro 2 or 3 for diesel and Euro 1 for petrol, with either Euro 1 or 2 for motorcycles, or the banning of all or pre-Euro 1 2-stroke motorcycles. In some regions LEZs are required to operate at least 3 hours a day for commercial vehicles and 6 hours a day for private vehicles, however are increasingly in permanent operation to increase their impact towards meeting the EU LVs. Public information has recently improved from extremely poor to patchily better. The variation in LEZ within the region has been extremely high, which is being gradually more co-ordinated within a number of regions.

Palermo in Sicily has an LEZ with two areas with emissions standards of Euro 3 and Euro 1. A motorway LEZ on the A22 motorway in Bolzano Province for pre-Euro 2 lorries is no longer in operation.

### 1.2.6. The Netherlands

The national environment and transport ministries and local authorities negotiated a national LEZ covenant with transport operators until national legislation can be put in place. The LEZs currently cover lorries only. LEZs for vans are likely to start in 2015, when they will have more impact, and have been discussed for cars, but are currently not envisaged. Standards are:

Until 2010:
- Euro 1 and less banned
- Euros 2 & 3 require certified DPF
- Euro 4, 5, 6, EEV, gas, hydrogen, E85 allowed in

After 2010
- Euro 2 and less banned
- Euro 3 require DPF & must be <8 years
- Euro 4, 5, 6, EEV, gas, hydrogen, E85 allowed in

After 2013
- Only Euro 4, 5, 6, EEV, gas, hydrogen, E85 allowed in

### 1.2.7. Sweden

The LEZ emissions standards are to be met by heavy duty vehicles, and are summarised below. A more detailed table of the standards can be found on the LEEZEN public website.

Until 2010: Vehicles must be < 6 years old, or those 6-8 years = Euro 2

From 2010: Vehicles must be <6 years old, or 6-8 years = Euro 3

Euro 4 allowed in until 2016, Euro 5/EEV[3] until 2020

The Swedish LEZs were the first LEZs in Europe, and started as a city-initiative without national involvement. They are also the only LEZs to have been successfully taken to court, due to using local standards and testing for retrofitting. After this court action the national authorities became involved and Swedish LEZs are now run on a national framework similarly to most other LEZs in Europe.

The emissions standards are set by a combination of age and Euro standard. It used to be possible to retrofit a DPF to meet the PM aspect of the Euro standard requirement. However, with the change to a national framework following the legal action, now if a vehicle is to be retrofitted the retrofit needs to prove that it meets the emissions standards for all pollutants within the Euro standard (ie PM, NOx, CO, HC). Previously accepted vehicles are still allowed in.

### 1.2.8. The UK

There is currently national framework, however the national Government is considering a $NO_2$-focused national LEZ framework. There is a full LEZ in operation in London, and bus- and $NO_2$-focused LEZs in Norwich and Oxford.

The official mechanism for the LEZ is a congestion charge, free to enter for vehicles meeting the emissions standards and significant penalties for those not meeting the standards, so it operates as if it were a 'traditional' LEZ. The daily charge is £200 for heavy duty vehicles currently, and will be £100 for light duty vehicles when they are included from January 2012.

From 2008

3Enhanced environmentally friendly (heavy duty) vehicle, set by the EU Commission, at a standard slightly tighter than Euro V

- Euro 3 for PM for lorries over 3.5 tonnes, and buses and coaches over 5 tonnes Gross Vehicle Weight (GVW)

From 3 January 2012:

- Euro 4 for PM for lorries over 3.5 tonnes GVW, buses and coaches over 5 tonnes GVW.
- Euro 3 for PM for larger vans weighing 1.205 tonnes unladen to 3.5 tonnes gross vehicle weight, minibuses weighing 5 tonnes or less gross vehicle weight plus other specialist vehicles

The two other LEZs are bus-focused LEZs, through agreements or the 'traffic commissioner', who is able to regulate buses and other vehicles. Outside London, buses are currently completely unregulated (deregulated), and the vehicles tend to be quite old. Norwich has a small LEZ in the city centre affecting local buses, operated by an agreement with the local operators, with an Euro 3(NOx) standard. Oxford is planning a bus-related LEZ, with compliance by 2014 for Euro V.

## 2. European Commission legal aspects

The aspect of EU law that most affects LEZs is the EU Freedom of Movement (FoM) Principle, one of the key aspects of the EU treaty. In terms of EU law, an LEZ is a potential barrier to trade (depending on how implemented), but justified under Article 30 of the EC Treaty due to the environmental imperative[4].

This means that in practice that:

- LEZs should not be any harder for foreign vehicles to comply than for national vehicles. Information on the LEZ needs to be spread EU-wide (if foreign vehicles are affected, which is often necessary for acceptance by national fleets).
- FoM also means that the emissions standards and retrofit certification should be in line with the EU vehicle Euro standards, as these are the only emissions standard accepted EU-wide. Standards such as meeting the PM aspect of the Euro 4 emissions standard (Euro 4(PM)) are acceptable.
- Retrofitting certification should also be based on the Euro standards.
- Motorways and TEN[5] key roads need to be exempted from LEZs, or have a reasonable diversion. The exception is motorways with all exits entering the LEZ (such as the ends of the M4 and M1 in London), with sufficient warning and exempted section to turn around if the driver mistakenly stays on the motorway. Motorways can be included (e.g. Tyrol) after discussion with the Commission, generally as long as not too many vehicles are affected, the action is proportionate and other options have been tried.

In Denmark, the regulation states that for TEN-roads: “roads regularly used as part of the international transit of goods through the country, including transit through ports or airports, may only be included in the LEZ if there are reasonable alternative transit routes outside the LEZ. The municipality may also exclude certain roads in the zone where there are special circumstances, where environmental health[6] can be considered of secondary importance”. Examples of key route exemptions are given in the maps of Copenhagen and Bochum in Figure 2.

The air quality framework directive requires that “Member States shall take the necessary measures to ensure compliance with the limit values”. The European Court ruled on 25.7.2008 that where EU LVs are exceeded, action plans are required. LEZs are one of the measures that the EU requires to be considered when Member States apply for extensions to the EU LVs[7], as part of a co-ordinated

4 Report from the Working Group on Environmental Zones for the European Commission, Feb. 2005.

5 Trans European Network roads, a network of roads with European significance, which is also under development with EU funding. Most motorways, harbour access roads or key bridges (eg Rhine/Humber), as well as the Paris Peripherique would also be included.

6 Environmental health covers the aspects of human disease and injury that are determined or influenced by factors in the environment. The health aspects of air quality come under this heading.

7 ANNEX XV, DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

package of proportionate measures aimed at the main sources able to be controlled by the Member State.

Generally when national Governments undertake measures that have the potential to affect the freedom of moment, or give financial incentives, these measures should be notified to the Commission. There are exceptions, e.g. for financial incentives when they are under a certain limit. However, low emission zones do not come under this exception, but have the potential to affect the freedom of movement, but are allowed under the 'environmental imperative'. Therefore national schemes should be Notified to the Commission. If France is considering whether it is able to not Notify about its LEZ framework, then this should not be done before talking to the relevant contacts in the Commission.

Individual local or regional schemes are not legally required to be notified, but the national government is responsible to ensure that these schemes comply with EU law. The possible exceptions are individual regional schemes where the region has direct reporting responsibilities to the EU. It is useful to discuss any new LEZ scheme or framework with the Commission before Notification, to ensure that the Notification goes ahead smoothly. Some local LEZs, for example London, discussed the LEZ with the Commission to ensure that it met all EU legal aspects, but did not Notify officially. Taking examples from elsewhere in Europe can help the discussions with the Commission. Further details on this are given in Annex 2.

The DPF grants in the Netherlands were deemed not to have to go through Notification, as there was to be sufficient grant for the whole fleet. No other grant schemes are known to have run into problems with State Aid rules.

The other two aspects of EU law that affect LEZs are the proportionality and non-discriminatory principles. Further details on these, FoM and Notification are given in Annex 2.

**Discussion points for France:**

- Exempting the major roads can be a problem if the major roads are the main problem. Vehicles that need to be cleaner to drive into the LEZ may well also be driving on these key roads, so emissions may be expected to be reduced on the key roads too. Excluding the very worst vehicles on key roads is allowed under certain conditions after extensive discussions with the EU Commission (see Austria, section 1.2.1). Relevant roads with lots of through-traffic would include the Paris Peripherique.
- The planned co-ordination of / framework for French LEZs would help with the EU legal issues, and should be notified, discussing with the Commission beforehand.
- It is wise to have a national website to inform vehicle operators about LEZs, as well as use other methods for wide dissemination (see section 3.1).

### 2.1. Other EU issues

In the recent EU consultations, vehicle stakeholders have lobbied for a single LEZ standard EU-wide. This is not possible due to the different situations around Europe, subsidiarity, and the fact that many LEZs already operate. The final EU Action Plan for Urban Mobility states that the Commission "has no intention of prescribing "onesize-fits-all or top-down solutions[8]". The Transport White Paper 2011 discusses 'an EU framework for ….. access restriction schemes and their applications, including a legal and validated operational and technical framework covering vehicle and infrastructure applications', but this has not yet been started.

The EU DG MOVE (Transport) recently undertook a study on Urban Access Restriction Schemes (ARS), which include LEZs (or Green Zones as the EU calls them). However, the recommendations may well only be implemented after the French LEZs are developed, and the main recommendations that is likely to be applicable is to implement best practice.

## 3. Best practice

There are many models of LEZs around Europe, each developed for the individual country. There are many useful best practice aspects that can be taken from the existing LEZs, as suits the French

8 Available at: http://ec.europa.eu/transport/urban/urban_mobility/action_plan_en.htm

situation. Best practice is something the EU Commission is looking at in their current work on LEZs (see section 2.1), and something the haulage industry is keen on.

Introducing LEZs with best practice has many advantages, including:

- Less resistance from vehicle operators
- Less likelihood of legal challenges
- Smoother operation
- Easier communication
- Best practice is in line with EU Commission wishes

The next section goes through a number of the key best practice issues in implementing an LEZ. In general, good examples of best practice can be seen in London, the Netherlands and Berlin. Different aspects may be appropriate in different situations, so best practice elements have been identified.

In terms of the best practice issues outlined, there are few disadvantages to following them. Where there are pros and cons or recommendations for France, this is outlined either with the best practice aspect, or in section 10, conclusions and recommendations.

### 3.1. Spreading information widely

This is required for three main reasons:

- to comply with the EU Freedom of Movement legislation.
- to enable vehicle operators to comply with the LEZ, which is harder if they cannot find the information on the LEZ. The higher compliance the more impact the LEZ will have.
- to reduce operator resistance.

There are a number of aspects to spreading information widely, such as

- Clear signs; good national and local websites; news coverage; support of and linking to LEEZEN; letters to those affected; adverts/placed articles in journals and newspapers; consultation; working with stakeholders; high profile, negotiation with stakeholders…

Dissemination of information to foreign vehicles would include adverts and leaflets at ports and border crossings, websites (national and city), working with trade bodies, journals and of course working through LEEZEN[9]. Notification to the Commission is also a form of information dissemination. Information should be available in as many languages as practicable. English should be included as the international language, together with the major foreign languages used in the LEZ. Alternatively/additionally, linking to the pages on the LEEZEN website will provide information in a clear format in 32 European languages.

Consultation before implementation of an LEZ can help reduce stakeholder resistance and helps disseminate information on the planned LEZ. Working with key stakeholders at an early stage of the LEZ process can, in the long term, save time and increase acceptance.

If the LEZs also affect private vehicles, then a more general public information campaign would also be recommended, and a general mailing to the population within the LEZ could be considered.

### 3.2. Emissions standards

The LEZs set up need to be estimated to have a positive impact on air pollution towards meeting the EU Limit Values, in practice for $PM_{10}$, $PM_{2.5}$ and $NO_2$. There needs to be a balance between the strictest LEZ giving the greater emissions standards and it being financially, socio-economically and politically possible. In terms of impact, there is also interaction between the emissions standards, vehicles affected and LEZ area.

As stated above, emissions standards should be based on the Euro standard to conform with the EU Freedom of Movement law, i.e. Euro 3(PM) or Euro 3(NOx).

9 with its public website of www.lowemissionzones.eu, and members services, for more details contact Lucy.Sadler @ airqualitypolicy.co.uk.

Allowing the retrofitting of diesel particulate filters enables a tighter standard than otherwise possible, (see retrofitting below) and is allowed in all LEZs except in Sweden, Prague and Austria. Norwich has and London and the UK are considering allowing the retrofitting of NOx abatement equipment to increase the impact on $NO_2$ concentrations.

### 3.2.1. Phasing

Phased implementation is a good way to implement an LEZ, and has been used by most LEZs. This means starting with a weaker emissions standard which is then tightened after a period of time. This allows the worst polluting vehicles to be removed at the first phase and the population to get used to the LEZ concept. The later phases of the LEZ, with tighter emissions standards will have more impact on air quality (as well as the fleet operators). The phases of the London LEZ have also affected increasingly smaller vehicles, as set out below. This also helps start the LEZ by affecting fewer vehicles (and therefore increasing the acceptability on implementation).

Phase 1 February 2008: Euro 3(PM) for lorries >12T

Phase 2 July 2008: Euro 3(PM) for lorries >3.5T and buses over 5T

Phase 3 January 2012: Euro 4(PM) for lorries >3.5T and buses over 5T

Phase 4 January 2012: Euro 3(PM) for vans between 1.205T and 3.5T and minibuses under 5T

For heavy duty vehicles, Euro VI vehicles are likely to have significantly better NOx emissions than previous Euro standards under urban stop-start conditions. Therefore including this emissions standard should be considered. While the first priority may be $PM_{10}$, the $NO_2$ limit values will also need to be met. Dutch research indicated that including vans in the LEZ would be more effective for $NO_2$ from Euro 4 diesel standard. German research indicates that retrofitting light duty vehicles significantly reduces primary $NO_2$ (see section 6.3).

Recommendations are given in section 10.

### 3.2.2. Retrofitting

Allowing retrofitting can enable a stricter standard to be set than would be otherwise possible, as the cost of retrofitting is usually lower than replacing the vehicle. If retrofitting is allowed, then there needs to be a certification scheme, which in turn needs to be linked to the emissions testing of the Euro standards. Certification needs to be done carefully, to ensure that the desired outcome is achieved, issues for PM retrofit include primary NO2 (section 3.2.3) and partial filters (section 3.2.4).

This section looks at best practice in retrofit, and retrofitting is dealt with as well in terms of recommendations for France in section 4.4. Concluding recommendations are given in section 10.

There are already PM-based retrofit certifications available in every country that allows retrofitting, while technology neutral, in practice for diesel particulate filters (DPFs). These schemes are variations upon a theme, with two schemes that stand out as being better than the others.

The best certification scheme is that for London, which requires full filters and a limit of 30% $NO_2$ increase and is available for heavy goods vehicles and heavier vans. Full diesel particulate filters (DPFs) allow for more PM reduction than partial filters. Full DPFs reduce PM by around 95%, including ultrafine particles. Partial filters have around 50% filter efficiency and do not function as well for ultrafines and can release the stored PM at a later time. Some DPFs increase primary $NO_2$, others do not, some even reduce $NO_2$ and NOx. As $NO_2$ is not regulated in the Euro standards, it has been difficult to regulate in the retrofit schemes, however London and Italy have done this. Details of the London certification scheme can be found in Annex 3 (a separate .pdf file).

The second best certification scheme is the Danish scheme, available for heavy duty vehicles and requires 80% PM reduction, which effectively requires full filters. It has no limit on primary $NO_2$. The Italian certification has a limit of no increase in NOx, HC and CO emissions and a maximum of 30% $NO_2$ in NOx emissions, however does allow partial filters but is available for light and heavy duty vehicles.

There is work on an EU-wide PM (and NOx) certification scheme, but this is likely to be outside the timescale of the French LEZ development, at least for the first phase.

The two certifications that certify DPFs for cars are the German and Italian certifications. Currently partial filters are the only real option for retrofitting cars, due to the higher costs of full filters. The certifications for the German and Italian schemes can be found in Annex 4, with the full text of the German scheme (in German) in Annex 4a (a separate .pdf file). The German scheme was

developed in conjunction with the Dutch scheme, with the addition of cars and a few other subsequent additions.

A French retrofit certification scheme could have a framework that adopted the London scheme for heavy duty vehicles and vans (potentially having a zero increase in primary $NO_2$ instead of the 30% limit), and the Italian scheme for light duty vehicles.

All LEZ certification schemes should accept as much of the information from other certification schemes as possible for practical as well as EU legal reasons. Foreign vehicles should be allowed to have any certified filter for EU legal reasons. Many existing certification schemes do this. The Netherlands has tried to encourage DPFs that do not increase primary $NO_2$ by giving grants, under complimentary action, only for those DPFs that do not increase primary $NO_2$.

#### 3.2.3. DPF retrofits and $NO_2$

DPF certifications have been based on the Euro standards, to ensure that they comply with the EU Freedom of Movement principle. As the Euro standards do not refer to $NO_2$, neither have the early certifications. However, DPFs using passive catalysts, often platinum-coated, increase primary $NO_2$, which has become an issue, both for some retrofits and newer diesel cars. Two DPF certifications (London and Italy) now tackle the primary $NO_2$ issue, meaning that other certifications can also do so.

Because LEZs reduce emissions of NOx due to removing the older Euro standard vehicles from the fleet, and retrofitting cars with DPFs has also been shown to reduce $NO_2$, even with this increase in primary $NO_2$, few LEZs have observed increases in $NO_2$. Some Dutch LEZs have shown a slight increase in $NO_2$, but these LEZs affect only lorries.

If certified correctly, PM retrofit does not lead to increased primary $NO_2$ – see section 4.4.

#### 3.2.4. Partial and full diesel particulate filters (DPFs)

For air quality, ideally LEZs would only certify (certainly for heavy duty vehicles (HDVs) full DPFs that do not increase primary NO2 for retrofitting for maximum impact on $PM_{10}$ and $NO_2$. As discussed elsewhere (3.2.2), most DPF certifications have interpreted EU law to say that partial and $NO_2$-increasing DPFs must be allowed. However, the London, Danish and Italian certifications now restrict one or both of these.

Full DPFs give 95-99% PM filtration, and also reduced ultra-fine particles (which are of more concern to health) equally to the larger PM emissions. Light duty partial DPFs have on average 37% PM filtration efficiency[10], heavy duty partial DPFs for 11-24T heavy goods vehicles (HGVs) give on average around 36-40% filtration efficiency in city driving, 30% motorways[11]. This confirms that while partial DPFs are not as good as full DPFs, if certified correctly, should give the predicted emissions in urban conditions.

### 3.3. The simpler to convey the better

As a general rule, the easier the LEZ is to understand, the more accepted it will be. This includes an easily defined area, permanent operation, as few exemptions as possible, easily understood emissions standard rules.

A well known boundary, such as a ring road can be useful. Where there are groups of cities or towns, a single LEZ may be more beneficial and easier to communicate then a ‘patchwork’ of individual LEZs.

In terms of European operation, there is a significant advantage to using similar standards and potentially stickers to existing schemes where possible, to reduce the ‘proliferation of different standards’, which is a key issue for the haulage industry.

### 3.4. National frameworks

National frameworks are highly recommended as best practice. They significantly ease information spreading; reduce cost, effort, time required to set up LEZs; and increase acceptability. The frameworks can be set up to enable sufficient flexibility for each city or region, as in the German framework.

10 TNO report, Evaluation of particulate filtration efficiency of retrofit dpfs for LDVs

11 TNO report, Real world efficiency of retrofit partial-flow diesel particulate filters for trucks

Other aspects are also useful to include in national frameworks. The Dutch framework also for example gives a 'roadmap to implementation', and a set of steps including the assessment that is required to be done before implementation.

As there are a number of different models already existing, new national schemes would benefit from being similar to existing LEZs if possible - or taking the best / most appropriate from each scheme.

Regional co-ordination of LEZs can also help to be a 'safety in numbers' measure, where neighbouring cities can avoid potential competition issues where they all have a similar air quality issue, and help in communication.

### 3.5. Good enforcement

The better the enforcement, the higher compliance the more impact the LEZ will have. Also poor enforcement brings the LEZ in to disrepute, as they are then not complied with, and those that do comply can feel cheated.

Enforcement methods vary, depending on what is practical or politically possible. A small LEZ affecting heavy duty vehicles only may make sense to be enforced manually. With a large LEZs affecting large numbers of vehicles automatic enforcement may make more sense. Compared with automatic enforcement, manual enforcement has lower start-up costs, but – if done well – higher operational costs. A combination of manual and automatic is also possible – stickers for manual enforcement, national vehicle database for automatic enforcement. Enforcement may be able to be combined with other traffic management measures in place or planned (such as physical barriers, areas currently accessible by permit only, congestion or other road charges). This is the case in Prague, London and planned in Norway for the last three options respectively.

Enforcement should be:

- Sufficient to deter non-compliance and achieve fairness for those who comply
- Points on the licence gives strong incentive to comply
- Fines and penalties: there should be sufficient to give an incentive to comply, for example comparable to the cost of complying, particularly if points are not used
- The less likely the vehicle is to be detected, the higher the penalty should be
- The higher the fine, the easier it is to enforce for foreign vehicles.

Some useful mechanisms used are:

- Manual enforcement in Denmark is additionally undertaken at unloading/delivery points, so that police are not as often needed to stop moving vehicles (in many countries only police can stop moving vehicles, but other officers can enforce on stationary vehicles).
- The German scheme, that affects private vehicles, has a 20€ fine and a point on the drivers licence. Its disadvantage is that the point on the licence is not enforceable for foreign vehicles, the advantage that it gives a significant incentive particularly for professional drivers to ensure that the vehicle they are driving complies.

More information on enforcement can be found in section 4.5.

### 3.6. Exemptions

The fewer exemptions, the more impact and credibility the LEZ has. However exemptions can also help increase acceptability. There needs to be a balance between ensuring those that really need to access the LEZ and are unable to afford a compliant vehicle can do so (see 3.10). Exemptions should be seen as fair, and the appearance that large numbers of vehicles are exempted should be avoided. It should be noted that the availability of exemptions have lead to increased enforcement in the Netherlands not leading necessarily to increased numbers of cleaner vehicles. Examples of some numbers of exemptions granted a number of cities in Germany and the Netherlands are given in Annex 5.

National co-ordination of exemptions increases clarity, acceptability and administration. In Germany and the Netherlands there are national exemptions, plus local exemptions valid just for that town – the best practice towns/cities having fewer local exemptions. In Sweden and London there are no

exemptions, although in London day passes can be purchased. In Denmark there are national exemptions plus exempted key roads locally.

'Hardship exemptions' are used in Germany and the Netherlands for those for whom complying with the LEZ would cause significant financial difficulties. These 'hardship exemptions' can be used to reduce the potential socio-economic impact of the LEZ without reducing significantly its impact, if they are strictly implemented. These are implemented as local exemptions for the specific town/city where the applicant lives or works and needs to access. The applicant must prove that retrofitting is not possible and they cannot afford a replacement vehicle. Businesses have to prove that the vehicle is essential to their business, they do not have the funds to replace the vehicle and retrofitting is not possible and risks the viability of their business. For example in Cologne, the hardship exemption can be granted to traders where operating a vehicle that meets the standards would threaten their business viability. This threat must be confirmed by an accountant, auditor, a Chamber of Commerce[12] or similar organisation. For Germany in the case of individuals, they need to prove that they cannot afford to replace the vehicle and retrofit is not possible. Hannover sets the measure of 'not economically viable' as the limits under civil law in terms of maximum monthly income, depending on the number of dependants (see section 18.2). Dutch hardship exemptions are issued on a case-by-case basis if the business has a low income, and the business's livelihood depends on having the relevant vehicle entering the LEZ. In the Netherlands the number of applications under the hardship clause (which prevents businesses experiencing serious financial problems due to the LEZs) is very limited.

Exemptions can also be used in the early stages of an LEZ, for example it has been used in Germany when there has been a relatively short notice period (see section 3.8) given for the LEZ. Where there was a difficulty in the delivery of sufficient vehicles or retrofit in time for the start of the LEZ, two approaches have been used. Exemptions in Germany, and giving drivers with vehicles that do not comply information letters as opposed to penalty notices in London.

The exemptions that are required by EU law are those for key transport or TEN routes (see section 2).

More information on the exemptions used in different LEZs can be found in Annex 5.

### 3.7. Labelling / identification options

If LEZs are manually enforced, then a windscreen sticker is recommended. They need to be obtained before entering the LEZ (for example Germany and Sweden). Stickers can add to 'peer pressure' for vehicle operators to have the newest stickers, depending on the relevant culture.

If LEZs are automatically enforced with cameras, the national vehicle database will, or needs to, have information for national vehicles. As there is no other way to identify the emissions standards of foreign vehicles, it is acceptable under EU law to require foreign vehicles to register with the LEZ authority, even if national vehicles do not have to, (as in London with an automatic enforcement). A database is also needed for those who retrofit their vehicles with a DPF or replacement engine.

Some British LEZs are aimed just at local buses, and are enforced by agreements and the local Traffic Commissioner.

#### 3.7.1. German sticker arrangements

The requirements for the German stickers are set out in legislation, full copies of these, translated into English, are in Annex 6, particularly sections 3 and 4. The stickers themselves are defined as 'non-reusable non-fading and forgery-proofed stickers', and described in full. The vehicle registration number is entered in the appropriate field on the sticker by the competent issuing body [ie, body selling/issuing the sticker, eg cities, TÜV, DEKRA, internet sales agencies etc] the using non-fading ink, and the sticker fixed to the inside of the windscreen. The sticker must be designed and fixed so that it self-destructs on removal from the windscreen.

The stickers are printed by private printing firms. They must comply with the specification defined and published by the Federal Ministry for Transport. They are issued to vehicle operators by organisations approved by the authorities under Länder law as well as the organisations that undertake the regular exhaust testing (such as TÜV).

The fee charged by the city authorities is around 5€. This includes the costs for printing them (estimated at 1-2€) and for the administrative efforts of issuing them (i.e. checking the emission

12 German firms are legally required to be members of these organisations

code number on the vehicle registration paper, selecting the correct sticker). Organisations issuing stickers are free in choosing the fee. The explanatory statement in the amending regulation for the German stickers (see Annex 6) gives the calculation of the *bureaucratic* costs of the stickers. This states:

*"Based on this calculation, the 1st phase of the procurement of the stickers will result in bureaucratic costs for the German economy of around EUR 412,000 and for the foreign economy* [of meeting the emissions standards, as there are for the German economy] *of around EUR 206,000. In the 2nd phase of the procurement the bureaucratic costs for the German economy are estimated at around EUR 618,000 and for the foreign economy at around EUR 209,000. In the subsequent years (from 2009) these will be around EUR 129,000 for the German economy and around EUR 65,000 for the foreign economy."*

### 3.8. Sufficient notice before scheme starts

Vehicle operators need sufficient time to plan for an LEZ, so a reasonable notice period should be given. This gives vehicle operators time to for example, re-arrange their delivery vehicles, purchase a new or second hand complying vehicle, retrofit, or contract out some deliveries, and can increase acceptability. There is no firm rule about how long needs to be given, however, the more warning that can be given, the better. An example of the timescale of a good practice LEZ is given for London. The London LEZ feasibility study stated that:

*"Should an LEZ be taken forward, there would need to be a period of 6 to 12 months to consult on, and if appropriate, formally make the decision to proceed (the 'go decision'). From the time of this 'go decision' it would take between 2.5 to 3 years to implement a low emission zone in London."*

However, this included the time that it would need to take the legal steps, as well as the notice to operators. In the event, the consultation process formally started in October 2005, the final scheme order was published on the 13 November 2006, and the scheme started on the 1st February 2008 for vehicles over 7.5T.

Where there has been a fairly short notice for the LEZ, there has often been an 'introductory phase', where drivers of vehicles that do not comply are given information leaflets as opposed to penalties.

### 3.9. Complimentary measures

Acceptance of LEZs can be significantly assisted if they are supported by complimentary measures. These include grants or cheap loans to retrofit or replace vehicles, improved public transport if the LEZ affects private cars, improved freight logistics for hauliers. Most countries, with the exception of the UK and Sweden have had financial incentives for retrofitting vehicles on the introduction of LEZs (in the UK grants were in place before the LEZ announcement, and then withdrawn on the reasoning that where there was a 'stick', a 'carrot' was no longer needed).

The complimentary measures for replacing vehicles come in two types: a) scrappage grants for older vehicles on purchasing a new vehicle or b) incentives (cheaper road tax, grants, cheap loans) for the very newest Euro V (or in future Euro VI) lorries. Scrappage schemes were in operation in a number of countries, usually for all cars over a certain age. However in Italy they were sometimes aimed at specific vehicles, for example in Lombardia has scrappage for pre-Euro 3 N class commercial diesel vehicles if with the 'simultaneous purchase of new N1 vehicles, if not diesel', or grants aimed at lower income groups.

The advantage of complimentary measures is that they can increase acceptability, the disadvantage their cost to the national/operating authority. Retrofit grants are the most common and LEZ-targeted form of complimentary measure. The scrappage measures are usually more general schemes in Italy linked with the air quality management plan, elsewhere they were often implemented alongside encouragement of the economy during the recent economic 'crisis'.

If retrofitting is not implemented in France, then cheap grants for the earlier upgrade of vehicles may be an option, as is done in Germany for new Euro V lorries through the nationalised KfW bank (see section 8.1.2), to enable operators to spread the costs of the new purchase over a longer time. The other measure is 'hardship exemptions' (see section 3.6), whereby those that are threatened with real hardship or bankruptcy can apply for an exemption. These two measures together should ensure that no-one is seriously disadvantaged by the LEZ. If loans are for any reason not possible, hardship exemptions should avoid any business needing to close due to the LEZ, or serious hardship of individuals.

### 3.10. Minimise negative inequality impacts

LEZs improve air quality for all, however poor air quality often particularly affects those in the lower socio-economic groups. On the other hand, LEZs have the potential to impact negatively on those on lower incomes, who are less able to afford newer vehicles or retrofits. This is particularly the case if the LEZs affects private cars and less (but not zero) if focused heavy duty – mostly commercial – vehicles. LEZs should aim to minimise any negative social or economic impacts.

There are a number of ways to minimise any potential negative impacts, in addition to those detailed above under complimentary measures. The best practice ones of these include:

- Allowing retrofitting reduces the cost of complying, as well as increasing the PM emissions impact.
- Where private cars are affected, proving public transport can ensure that those without access to a compliant vehicle can still access the LEZ.
- Hardship exemptions as used in Germany and the Netherlands (see section 3.6).
- In Germany and Italy where private cars are affected there are also exemptions for those who are unable to afford a compliant vehicle and their working times are when there is no public transport available.
- Consideration of the emissions standard - the tighter the standard the more potential socio-economic impact – but also the more air quality impact. The German LEZ framework has minimum Euro standards 2-4 for diesel, but Euro 1 (or a catalytic converter, which in Germany were available before Euro 1) for petrol vehicles. The fitting of a catalytic converter for Euro 1 vehicles made a significant impact on emissions from petrol cars. This means that most petrol cars can operate if they are younger than around 1990/1992 (ie now up to 20 years old), whilst still removing the very worst polluting vehicles (both petrol and diesel). While France has a higher percentage of diesel car ownership, petrol cars are often cheaper to purchase than diesel cars, it would be worth research into whether it is also the case in France that those on lower incomes are more likely to own petrol cars.

Italian LEZs often (although now decreasingly) use time slots so that those on lower incomes can access the LEZ, however this gives a more complex yet less effective LEZ and would not be recommended as best practice.

### 3.11. Appropriate assessment

Before implementing an LEZ assessment is needed to ensure that the planned LEZ is likely to have a positive impact on air quality – an essential requirement to implementing an LEZ. Following implementation, there needs to be a monitoring program to ensure that the LEZ is having air quality improvements. The pre-implementation assessment is useful in pre-LEZ consultation, both are useful in communication.

Pre-implementation assessments need to be done with the aid of models. Post-implementation assessment of LEZs is also not straight forward, and best practice of post-implementation assessments should include using both monitoring and modelling.

Modelling should include data such as the compliance rate, how operators are likely to comply (alter travel, buy new, retrofit, which will affect the vehicles predicted emissions), exemptions etc, as well as comparison of with LEZ and business as usual. When using air quality monitoring data, non-LEZ variables (such as the weather and other air quality measures) need to be accounted for. Where there is a dense and suitable network of monitoring sites, trends inside and outside the LEZ may be able to be used. A particularly good example is in the Rhur area of Germany, where there are many monitoring sites as well as monitoring of comparable sites inside and outside the LEZ. However, this is not always possible, for example where there is not a dense network of monitoring stations, or where there are not similar cities without LEZs (for example, London, Berlin, Paris). Where comparison of monitoring inside and outside the LEZs are not possible, assessment is harder, and particularly good examples can be found in London and Berlin, the reports of these cities should be consulted in more detail for the useful methods used, as well as section 20.1.1 for Berlin.

Assessments will be limited by the data available, so data collection for assessments should be planned in with the LEZ development. The pollutants covered should include those prescribed by

the limit values of $PM_{10}$, $PM_{2.5}$, $NO_2$ as well as NOx and black carbon / diesel particulate / smaller particulates. It is currently considered that smaller particles than $PM_{2.5}$, especially black carbon or diesel particulates are more dangerous to health than $PM_{2.5}$ and $PM_{10}$ - also the pollutants more affected by the LEZ. It remains to be seen whether the upcoming European Commission air quality review recommends a change in particulate limit value metric.

LEZ monitoring is often a local issue, giving variation in quality. There is advantage in either co-ordinated, potentially national, assessment or giving guidelines for assessment, as in the Dutch 'road map' and national assessment.

Further details of LEZ assessment methods are given in section 6.6.

### 3.12. Increasing acceptance

Most of the other best practice aspects in this section increase public and political acceptance of the scheme. A number of additional issues are covered here.

The knowledge, or acceptance, that there is an air quality problem is a very useful aspect in acceptability of any air quality action. This makes action particularly in larger, accepted-as-polluted cities easier. For example, in London no-one doubts that there is an air pollution problem and the majority of the population wanted something done. Ken Livingston, the first Mayor of London, won his second election partly on the basis that he was going to implement an LEZ (for heavy goods vehicles and larger vans) and clean the polluted air.

Carrying on from the above point, good public understanding is essential to acceptance. In a number of countries there have been air pollution campaigns, raising the issue of air pollution. One example is ATE (Association Transports et Environnements) in Switzerland, with 'a filter in the town', and their PM10.ch website, with regularly changing campaigns and their lung logo. In the UK the recent re-estimating (and significant increase) of the number of people estimated to be killed by air pollution has increased public discussion and concern about air pollution. Another example that has been well received is Sheffield's Care4air, although it is without an LEZ. Consultation on the LEZ before formal decision to implement can be part of this increasing public understanding.

The choice of emissions standard and vehicles chosen will affect the acceptability. As a rule of thumb, the more people affected the more resistance. In many LEZs heavy duty vehicles are targeted, which gives a higher cost-benefit, with each vehicle changed making more impact than it would for a smaller vehicle, although a smaller total impact.

Phasing implementation, both with the size of vehicle and emissions standard have been used in many countries, and helps reduce the impact on vehicle operators at the outset, and so increase its acceptability.

Having the LEZ championed by the Mayor or political leader makes implementation easier. Dissent amongst the politicians can increase this in the population, as well as prevent LEZs being implemented. In Germany the ADAC (German Automobile Club / AA) has led significant dissent in the public domain, with many (unsuccessful) court cases against LEZs. Making a clear case for the LEZ helps acceptance.

Having a national framework is an important part of acceptability that makes it easier for vehicle operators to understand about LEZs and know where they are. If the LEZs are manually enforced, there should be a single national set of stickers that are valid for all LEZs, there is a lot of resistance to even the different stickers in the EU countries, and having more than one sticker per country would increase this resistance significantly. National frameworks also save significant effort, cost and legal risks in setting up the LEZs.

Complimentary measures can significantly help the acceptability of the LEZ. Leading by example. Exemptions can improve acceptability, and should be used carefully so as not to significantly reduce the impact of the LEZ. Acceptability can be reduced if the city authorities or buses operate non-complying vehicles.

It should be noted, as with many measures affecting the business community the complaints and fears of the business community before implementation have been significantly higher than that actually experienced once the LEZs have been implemented. This is discussed further in section 7.3)

The fact that there are many LEZs in Europe helps acceptability, that it is not 'just here' that there is an LEZ. Depending how they are counted there are around 225 LEZ in Europe, or over 2000 if every commune in the Italian regions is counted.

### 3.13. Good practice recommendations from Gothenburg

The Swedish LEZs were originally implemented as local measures by three major cities co-operating without national support. The key learning points of Sweden's LEZ implementation were outlined by Gothenburg:

- The core implementation group was useful to share experiences and decisions, although it should have done more to involve vehicle operators.
- A good management and leadership from the traffic authority was important.
- Co-operation between Sweden's three largest cities enabled success – implementation in just one city would probably not have been possible.
- Constant contact between the cities was required to ensure that the rules and regulations were similarly implemented. Separate stickers were originally required for each city. This would have been simpler if operated by the Swedish National Road Administration.
- The goodwill effect was also noted, with the LEZ in Gothenburg potentially giving an additional argument in favour of businesses and visitors choosing *for* Gothenburg.
- A clear and simple strategy helped.

The difficulties included:

- A negative attitude among sections of the transport industry's players, with objections and delays as a result.
- Lack of active support and participation on the part of the Swedish National Road Administration, which cost time and energy.
- Classification, rules and regulations were the most difficult technical problem. Many different interests and competence areas had to be involved. This therefore took a long time and should have begun much earlier.
- The way permit processing was organised should have been improved, compliance inspections implemented and information conveyed should have been better.
- Investigating and deciding on which vehicle standard and the lack of diesel particulate filter (DPF) in the introductory stage.

### 3.14. Italian LEZs

Ademe raised a question about following the example of the Italian LEZs. When looking at best practice, Italian LEZs have not tended to follow best practice standards as well as other countries. In terms of the criticisms of the haulage industry about LEZs, many of the issues raised have come from the Italian LEZs. The situation in Italy is gradually improving, but other countries give better models to follow.

In Italy there are regional agreements instead of a national LEZ framework. There was an overall regional agreement between the north Italian regions, giving a minimum standard for LEZs that would be implemented. Some regions then pass this structure on, giving a large amount of variation in standards between cities, sometimes identifying the cities to be implemented with LEZs by those over a certain population. Since that start, LEZs are moving on, and some regions now give more structure to the agreements, specifying the emissions standards to be implemented in the region and giving some joint communication. Both types of agreement also outline financial incentives and non-traffic measures.

Best practice issues with the Italian LEZs have included:

- Little co-ordination, rules varying from commune to commune even where there is a regional framework

- Complicated rules, including different time periods / days[13]
- Little communication[14]
- Often short notice periods before implementation, eg confirmation on the 28th December that the scheme will continue after the 31st December, and there is not always an announced, planned, progression in standards
- Long lists of exemptions. Often including vehicles owned by the government authorities, which does not show the authority 'leading by example'. Looking at the range of exemptions, it appears that in effect the LEZ is aimed at commuters, as these are the vehicle operators that are less likely to be able to get an exemption. However in terms of pollution, it is more effective to target heavier vehicles.
- There is often no map of the LEZ area given, but a list of roads that are exempted within the commune, and for which sections of these roads they are exempted. This does not make simple communication.
- Impacts rarely assessed before or after implementation (unless they done but not in the public domain).
- With the exception of Bolzano, stickers are not required, making enforcement less easy and clear.

An example of Italian emissions standards is given below (Trentino) from November to March:

- 1 November 2010 to 31 March 2011:
  - Petrol Euro 1,
  - Diesel Euro 2,
  - 2-stroke motorcycles & mopeds Euro 1,
  - Goods vehicles (M2, M3, N1, N2, N3) Euro 3 if not fitted with a certified diesel particulate filter.
- 7 January 2011 to 31 March 2011:
  - In addition ban diesel cars Euro 3 if not fitted with a diesel particulate filter; and
  - On Thursdays only, diesel & petrol cars Euro 4(PM), mopeds & motorcycles Euro 2.
- The LEZ operates from 08:30-18:30 during both timeperiods

In terms of simpler standards for different vehicles, in Germany there is a different standard for petrol and diesel, and London where there is a different standard for heavy vehicles and vans.

The best practice example in LEZ in Italy is the Milan Ecopass scheme. This is a combination of LEZ and congestion charge, automatically enforced, with differing charges for different vehicle types and emissions. This is well communicated, and while the payment structure may be complex, it does not ban entry (instead charging). The Ecopass scheme has been successful in its two joint aims of reducing emissions and traffic.

## 4. Implementation issues

Collected in this section are a number of important issues related to implementation. These can be seen as linked with the best practice section.

### 4.1. LEZ location issues

The emissions standard, vehicles affected and area of the LEZ need to work together to have a sufficient impact on air quality. The 'simplicity principle' is a useful one to consider with the LEZ area, as is where the authority has influence, either directly over its own area, or with neighbouring

13 This is in many regions gradually turning to permanent LEZs. Italy is the only country where LEZs are not always permanently in place. The reasoning given is to give those on lower incomes the ability to still access the LEZ with less convenience.

14 This is slowly improving, but there is still no national Italian LEZ website or information portal. The only collated information on Italian LEZs is on the LEEZEN website.

areas in discussion/negotiation. Often the LEZ covers the area over which the authority has power. Another boundary used is the air quality management area.

Where there is a relevant ring road, this can make a useful boundary, as it is easily identifiable and it gives a good by-pass for non-compliant vehicles. Significant ring roads, such as the M25 and the Paris Peripherique are (likely to be) European TEN-roads and therefore required to be exempt. The disadvantage of this boundary is that the ring road may well be a highly polluted area itself, and not be reduced as much if it is outside the LEZ.

The London feasibility study also investigated smaller London LEZs (central and inner ring roads) as well as a collection of town centre LEZs. The study found that these would have not been effective in terms of air quality impact, and the several town centre LEZs would have been difficult to communicate. The LEZ in the Rhur area in Germany is currently a 'patchwork' of LEZs, but is now changing to a single LEZ over the whole area after experience of the current scheme.

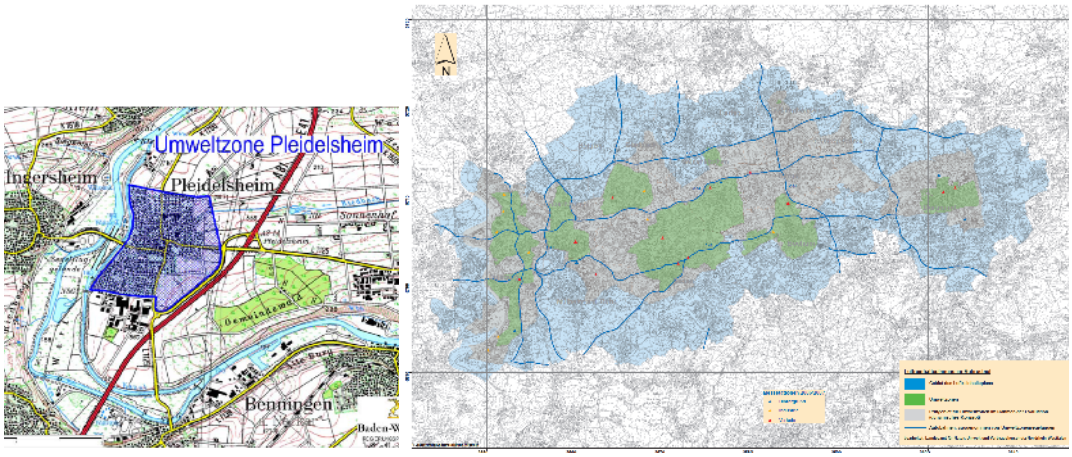
Motorway LEZs are rarely able to be implemented due to EU law, and motorways often have to be exempted from LEZs (see section 2). The exemption is where all the exits go into the LEZ, and with enough 'space' that someone can turn around if they stay onto it by mistake (for example the London LEZ).

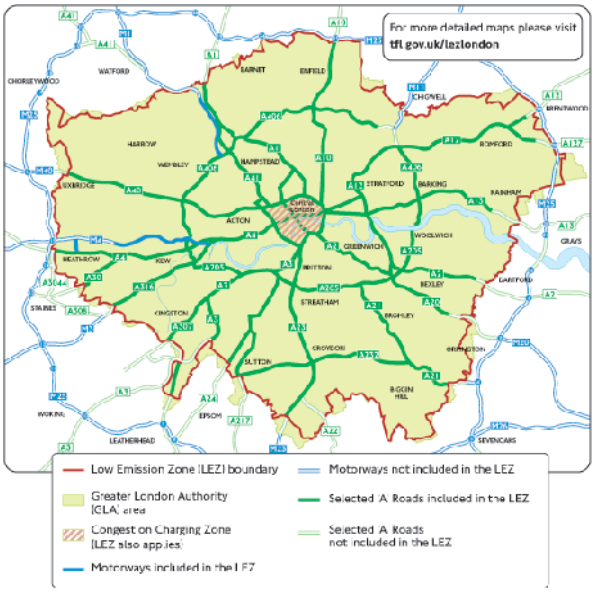
There is only one example of LEZs on a single road link, which is the main road in Maastricht town centre, where research has shown that gives beneficial impacts throughout the area (and presumably is easier to enforce manually than a larger area). There have been other two examples of single road LEZs that are no longer in operation as such. A single urban road in Dortmund that was 10 months later included in a larger urban LEZ, and an industrial estate access road in Maastricht which was withdrawn as it did not comply with the national framework of urban LEZs.

### 1.1.1 Types of LEZ locations

Areas covered by the LEZs range from small towns such as Pleidelsheim with a population of 6300, to the current 'patchwork' LEZ in the Rhur area of Germany, and of course the London LEZ. The following maps give an example of LEZ areas, more available from www.lowemissionzones.eu. Figure 2 gives the LEZs in Copenhagen (Denmark), Bochum (Rhur area, Germany) and Cremona (Italy) with different routes exempted. In Copenhagen exempts the key harbour access road, and Bochum the motorway – both due to EU law (see section 2). Cremona identifies the roads exempted as 'park and ride' access, however they does cover a large proportion of the larger roads in Cremona.

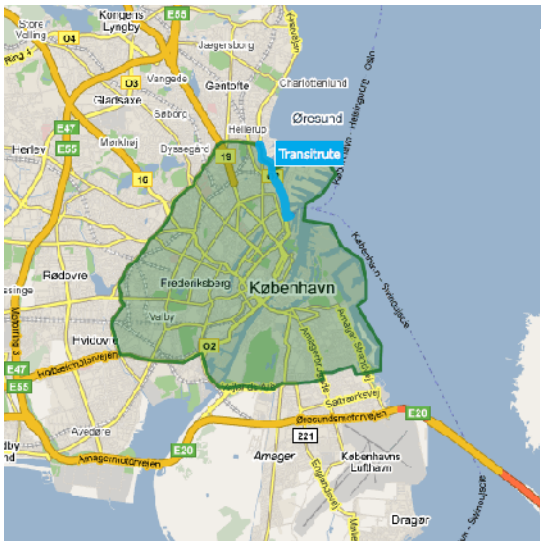
**Figure 1. Pleidelsheim, London and Rhurgebeit LEZ areas**

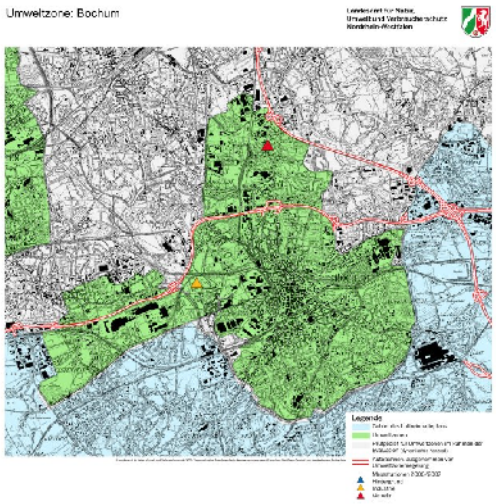


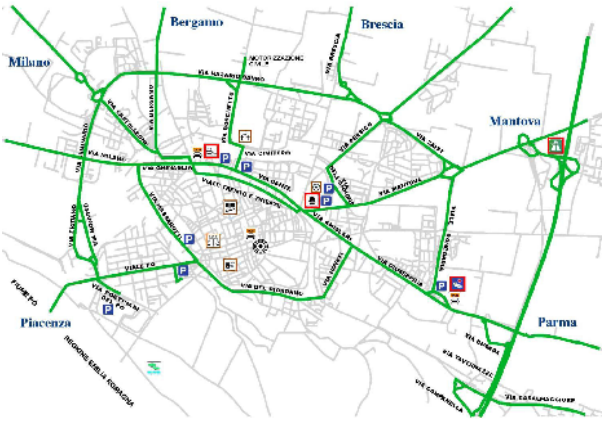



In many LEZs certain roads are exempted, for example motorways, roads accessing harbours or Park & Ride sites, such as those below.

**Figure 2. Copenhagen, Bochum and Cremona LEZ areas with exempted roads** (in blue, red and green respectively)



#### 4.1.1. Outside the LEZ area

One issue raised by areas just outside by bordering on the LEZ boundary is the fear that the LEZ will make pollution worse in their area, as the dirtier vehicles will then travel there. Both London's feasibility study (see weblinks to the feasibility study 2003 and Strategic Review 2004/5) and more widespread experience have shown this not to be the case. In fact, neighbouring areas have improved air quality as many vehicles based just outside the LEZ will comply to enable access to the LEZ, and cleaner compliant vehicles will travel through that area to reach the LEZ. It has not been reported, but there is possible that there could be a diluted impact in eg more rural areas further away from the LEZ where the second hand vehicles are sold, or where large vehicle operators re-organise their fleet. However this will also be balanced with vehicles there complying and very much depends on whether the vehicles sold stay in the country or 'move east', or how many vehicles retrofit as opposed to replace their vehicles.

### 4.2. Vehicles types affected

As a general rule, heavier vehicles are the more cost effective vehicles to target with an LEZ. However, the situation is likely to be different if two-stroke motorcycles are a significant pollution source. Affecting more vehicle types will have more impact, particularly for $NO_2$. Including other vehicles is often a politically affected decision. In some countries including private cars would be very difficult, in others this is more possible. Affecting all vehicles can on the other hand be seen as fairer by the transport industry.

All current LEZs affect heavy duty vehicles, they are more polluting per vehicle, often make most air quality impact, there are fewer individuals involved giving advantages from both a political and enforcement point of view, and heavy goods vehicles can be more effectively retrofitted with full diesel particulate filters.

Where cities/countries have an older bus fleet, such as in the UK outside London, bus-LEZs have been implemented, for which there are mechanisms that can control bus emissions that do not affect the general vehicle fleet. Dutch research indicated that light duty vehicles were more likely to be effective for post-Euro 4 vehicles. A 2009 study for the Danish Environment Ministry found that LEZs for cars and vans had short-term benefits that reduced quickly and with socio-economic losses. The overall cost-benefit was negative – although all calculations have a significant amount of uncertainty surrounding them[15]. There is more information on these studies in section 20.7.

Account needs to be taken of the vehicle flow in the city. In some cities it may be that heavy goods vehicles are a small proportion of the vehicles travelling in the city, so affecting these vehicles has less impact than say including vans or cars.

Including cars in LEZs has the potential to give a traffic reduction impact. This may be as drivers decide that rarely go by car into the city find it more cost effective to change to public transport than to change their vehicle (modal shift [report modal in French]), or decide not to make the trip at all. However, change in traffic flows has in practice not been observed, although there is some very limited reporting in Munich that suggests fewer vehicles are registered in the city, but this cannot be directly attributed to the LEZ.

### 4.3. Vehicle Euro standard identification for national databases

In France, the national vehicle database does not include the Euro standard of the vehicles. This is a problem with implementing a LEZs. In the UK they had the same problem before implementing the London LEZ, and the French ministry can learn from their method, described in this section.

Transport for London (TfL), who run the London LEZ uses as the main source of data the date of first registration to identify the Euro standard. For their Euro III and IV standard this means using the type approval 'all types' date of 1 October 2001 and 1 October 2006 when Euro III and IV became mandatory for all production. Hence subject vehicles registered before these dates, are assumed to be of the previous Euro standard. However, this does not cover all vehicles, as there are:

- 'early adopters', for vehicles from manufacturers who met the Euro standard before the mandatory dates
- derogated vehicles sold after the mandatory Euro standard date

15 The Danish 2009 study is called: 'Samfundsøkonomisk analyse af "Effekter af miljøzonekrav på person- og varebilsmarkedet"', undertaken for the Danish Environment Ministry

- vehicles which are retrofitted with fitting a diesel particulate filter
- vehicles that have a dedicated gas conversion
- vehicles that have adapted their emissions by other means.

For 'early adapters' TfL contacted the UK vehicle certification agency to get contacts for the homologation managers for each manufacturer of vehicles sold in the UK. These homologation managers were then contacted and asked for the VIN (Vehicle Identification Number) of the vehicles that were 'early adopters'. TfL explained in their communication that it was to the manufacturers best interests to reply. For manufacturers for which TfL did not have 'early adopter' VIN numbers, the penalty notice to the vehicle operator would state that it may be that the vehicle meets a higher Euro standard, and that they should contact the manufacturer directly to confirm if this might apply. This would give the manufacturers much more work, and bad publicity, if each vehicle operator contacted them individually. For some manufacturers identifying 'early adopters' was quite easy and it was often a suffix of the VIN number that identified the Euro standard. While not all manufacturers replied, many did, and for example for the UK van market they have around 50,000 'early adapters' with around 10,000 ford transit 'early adapters' alone in the UK.

TfL give the owners of 'derogated vehicles'[16] the benefit of the doubt and assume that they meet the standard that they should have for the date sold.

The process for vehicles retrofitted with a diesel particulate filter is to:

- buy and fit a DPF from the TfL approved list
- take the vehicle to VOSA (the annual vehicle inspection agency) where there will be a smoke test undertaken and the identification number of the DPF checked
- VOSA will then issue a 'Low Emissions Certificate' and pass the information to TfL for their database

Vehicles with a dedicated gas conversion will have their fuel type altered on their vehicle registration, and therefore be on national vehicle database. As only diesel vehicles are affected, this vehicle will no longer be affected by the LEZ.

Vehicle operators who have proof that their vehicle meets a higher Euro standard than its age would suggest (e.g. newer engine fitted), can register individually with their evidence.

While the fact that the London LEZ is automatically enforced makes this database easier to operate, where manual enforcement with stickers is used those agencies selling the stickers would have to have access to this database.

### 4.4. Retrofitting

It is understood that France would like to have a retrofit scheme that targets both PM and NOx/$NO_2$. As stated in section 3.2.2, there are currently retrofit certification schemes in operation for PM. For NOx there are retrofit certification schemes in preparation for NOx (see section 4.4.2), however as yet there are no schemes in operation. We would recommend including retrofitting into the phasing of the LEZs – as planned in London. This would mean for the first phase of LEZs adopting or adapting the London and Italian retrofit certifications for PM. Then in a second phase (maybe together with a tighter emissions standard or additional vehicles (see section 3.2.1)) requiring retrofit of both PM and NOx for heavy duty vehicles only. The following two sections set this out in more detail.

#### 4.4.1. PM retrofitting

We would recommend adopting or copying the London retrofit scheme for heavy duty vehicles and heavier vans (over 1.205T), and the Italian scheme for the lighter duty vehicles (under 1.205T) as opposed to setting up a new certification scheme. This would have the advantages of enabling a scheme to be quickly set up, have a wide range of products already certified, and reduce operator resistance. This reduces costs of certification (for both the authorities and manufacturers) therefore reducing the cost of the LEZ and retrofits. The only adaptation that France may wish to do to the

16 where a manufacturer can sell off old stock after the mandatory Euro standard date –subject to an application to the type approval authority in the country concerned and not exceeding 10% of the volume of new vehicles sold in the preceding year

London certification is to require no increase in primary $NO_2$ (and potentially CO and HC too) as opposed to the 30% increase in the current London scheme. However, this change would need to be done carefully to ensure that it was legal within EU law. The London scheme was amended to include reference to $NO_2$ after consultation, so this may be a route that would help. The Italian scheme requires a maximum of 30% primary $NO_2$ in the NOx exhaust for all vehicles, but does not require full DPFs, hence the London scheme for the heavier vehicles and the Italian scheme for lighter vehicles.

An alternative in theory would be to require retrofits to meet all pollutants of the Euro standard to be met (is at least one dpf that can do this). This is officially done in Sweden, but there is no formal certification scheme published, and HC and CO are in practice no longer of concern. However a new certification would have to be developed and so this is not a recommended way forward.

### 4.4.2. NOx retrofitting

There are three types of retrofit already developed that can reduce NOx emissions:

a) Some dpfs reduce PM and NOx to meet the lower Euro standard. There are currently 3 DPFs that reduce NOx by 30% and so can move heavy duty vehicles 'up' a Euro standard, from Euro I to Euro III. They just miss moving Euro IV to Euro V.

b) The non-platinum coated DPFs also reduce, or do not increase, primary $NO_2$, and can give some NOx reductions. These for example use fuel borne catalysts (FBC) with base metal or iron.

c) Systems that combine a DPF with SCR (selective catalytic reduction) or EGR (exhaust gas recirculation).

Both types a) and c) are available only for heavy duty vehicles, type c) in particular due to the higher cost of systems. It currently looks unlikely that systems would be cost effective for significant NOx reduction for light duty vehicles.

There are two NOx retrofit schemes in preparation, one on a European level, and one under the VERT scheme – both for heavy duty vehicles), and consideration for a NOx-retrofit based LEZ framework the UK.

On the European there is increasing support for a EU-wide PM and NOx retrofit certification, from both DG MOVE and ENV. On a practical level, there is an UN-ECE working group 29 on retrofit, firstly only with respect of Euro VI/5 to be based on the Comitology procedure to enable it to be law, but will also be extended to Euro 2 and 3, and for PM and NOx. It is intending to be a proposal in June 2012, based on the German Anlage XXVII, but additional aspects included eg secondary pollutants and looking at PM reduction of 97-8% (so full filters only, no partial filters). Further information from their website. There 5 target groups:

a) reduce PM
b) reduce PM and not increase primary NO2
d) reduce PM and reduce NOx (ie DPF & de-NOx)
e) reduce NOx
f) DPFs that reduce both PM and NOx (which now exist)

The VERT certification scheme is used extensively in heavy duty off-road and is often accepted as part of the testing for LEZ certification schemes. As it is based on very different testing as the Euro standards, it has not been used in LEZ schemes. They are preparing a combined PM and NOx certification scheme, due to be finished in Autumn 2011.

The UK is considering a NOx-retrofit based LEZ framework, and is currently at a feasibility and investigation stage. It is mentioned in the draft of the submission for an extension to the NO2 limit values. The UK has a significant $NO_2$ exceedence issue, but only London has an issue with $PM_{10}$ exceedences.

A certification scheme for NOx needs careful consideration, in particular as SCR does not always work at low engine temperatures – ie in urban operation. Therefore any certification scheme needs to take drive cycles into careful consideration. As there is no current NOx certification scheme in operation, and it is likely to take a while to develop one, we would suggest that NOx retrofit was implemented in a second phase. This gives enough time for a certification system to be developed, in conjunction with the UNECE scheme and potentially a UK scheme if this is taken forward.

As there is in practice no NOx retrofit for light duty vehicles, it would make sense for the NOx retrofit to be only for heavy duty vehicles, justified by the low cost-effectiveness or cost-benefit of NOx retrofit for light duty vehicles. $NO_2$ could be included in the light duty vehicles in terms of not allowing DPF retrofit that increased primary $NO_2$ (ie adopting the Italian light duty certification scheme).

### 4.5. LEZ enforcement choice

Several factors can affect the enforcement choice.

- **Numbers of vehicles**
  The higher the number of vehicles affected, the more efficient camera enforcement can be. In the case of London they decided that if vans were to be included camera enforcement would be needed to effectively and affordably enforce that large number of vehicles.
- **Size of zone**
  Together with the number of vehicles, a large zone can be expensive to enforce well due to the number of vehicles and large area.
- **Political realities / cultural attitudes**
  In some countries such as Germany camera enforcement is politically very controversial, in others camera enforcement is less of an issue. In some countries more or less enforcement may be needed to ensure compliance with rules.
- **Legal option chosen**
  Outside France, camera enforcement may require non-compliance with the LEZ to be a decriminalised offence, so that enforcement can be under civil law by the LEZ or local authority as opposed to by the police. However, in France all traffic offences are under criminal and administrative law, so this may not be relevant. A congestion charging mechanism (eg London and Milan Ecopass) can require camera enforcement to get the 100% capture rate required.
- **Police availability**
  In some countries a local authority would need to pay for police time, which significantly increases the cost of the LEZ to the authority. Where police undertake regular vehicle checks and stops, incorporating LEZ enforcement in these actions may be less additional work than where there are few normal vehicle checks.
- **Other schemes in operation**
  LEZ enforcement may be able to be combined with existing permit access, congestion charging, road/motorway toll schemes.

Pros and cons of different the enforcement mechanisms:

**Manual** enforcement can be cheaper than automatic systems to set up, but can be expensive to run. It is likely to provide lower compliance rates, and is likely to require police time to stop moving vehicles. Allowing enforcement of stopped vehicles by ‘enforcement officers’ can help reduce these costs, both when parked or unloading. It can be easier to hand penalty notices to drivers (including foreign drivers) as the vehicle is stopped – chasing up payment may well still require separate identification of the driver through national vehicle registration databases. National government co-ordination and sticker systems make manual enforcement easier.

**Camera** enforcement can be useful – if politically acceptable in France – if there are large areas or numbers of vehicles involved. If compliance is likely to be low with manual enforcement, then camera enforcement can be useful to ensure air quality improvements from the LEZ.

**Electronic** enforcement may be possible if it can be based on another scheme, for example in Norway, or if there are rising barriers in the very centre of a city or at the start of bus lanes.

**Combinations** of camera and manual enforcement could be used, either for different cities, or where there are just a few cameras set up, however the set-up costs for this should be considered.

A poorly complied with LEZ looses air quality impact and credibility. Whatever enforcement choice is chosen, good compliance needs to be ensured.

### 4.5.1. Different LEZ enforcement choice used around Europe

Most LEZs are manually enforced, but cameras and transponders (electronic device that transmits payments to the toll-stations – in French transpondeur) are also used, generally country-by-country, as below:

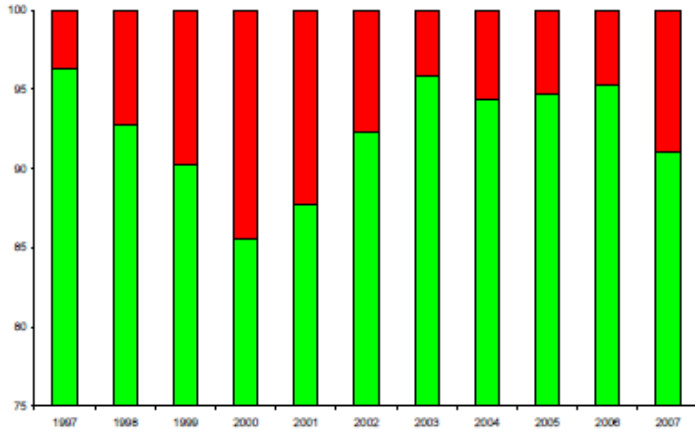
- Manual enforcement is used in the Swedish, Austrian motorway and German LEZs. In Germany the resources devoted to this vary from city to city.
- The Dutch LEZs started with manual enforcement but are gradually moving to camera enforcement
- Most Italian LEZs are manually enforced however a few have camera or even electronic enforcement, often when combined with another scheme or pedestrian zone.
- The Danish LEZs set out the 3 manual enforcement methods used as:
  - Firstly municipal inspectors when lorries are visiting a company
  - Secondly town traffic wardens checking vehicles parked on the street
  - Finally, police at routine roadside checks. Both inspectors and traffic wardens can call on the police when needed.
- The London LEZ and Milan Ecopass are camera enforced
- The Norwich and Oxford LEZs (UK) are enforced through agreements with the (deregulated[17]) local bus operators.
- The planned Norwegian LEZs intend to use the same electronic device system as used for motorway tolls (AutoPass, see section 1), with camera and manual enforcement also possible, as well as cameras to enforce those who do not pay.

### 4.5.2. Compliance rates

The figures in section 6.4 show the high compliance rates that are able to be achieved with London's camera enforcement, and for Berlin with a well enforced manual scheme. Figure 3 below shows data from Stockholm city's 2008 assessment of the LEZ for their (manual scheme), with poor compliance in 2000, which was subsequently improved with more effort after this was investigated

**Stockholm**

**Figure 3. Compliance with Stockholm's LEZ** (in %, red=non-compliance)




If all vehicles had been fully compliant, then the concentrations would have been reduced by between 0.5% and 12% as opposed to 0.5% and 9%[18] (for assessment information see section 20.3.1). Figure 3 shows that the assessment was done at a time of particularly low compliance.

17 Or unregulated – see section 1.2.8. Most buses in most countries are regulated (controlled) or operated by the local authorities (LAs). In the UK outside London, buses have been 'deregulated', or are no longer controlled by the LAs but operated by private companies where they feel they would make most profit. This also explains why the UK bus fleet is generally quite old and therefore bus-LEZs can make significant impacts. New legislation in the UK is now giving LAs some more control over buses.

18Christer Johanssen, Stockholm City Authority, various presentations and communication

**Germany**

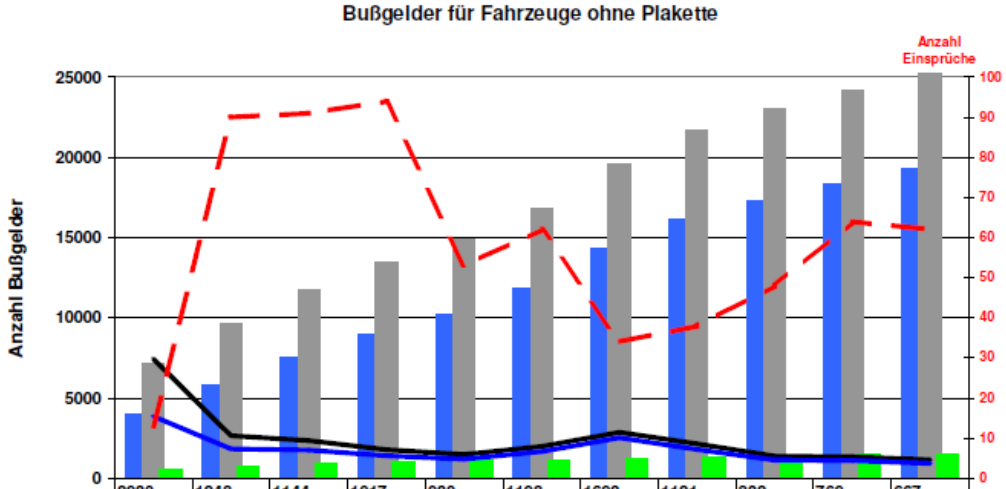
The following enforcement/compliance figures are a small LEZ in Mannheim and a larger one in Berlin. However, these figures are very much dependent on the amount of effort put into enforcement. It is likely that Berlin is putting much more effort into enforcement than Mannheim, over and above that which one would expect from the size differences.

- Mannheim (population 306,700) has been controlled since July 2008, and 19 penalties enforced (October 2009).
- Berlin (population 3,396,990), between February 2009 and 4th June 2009, 14,480 penalties given by police, 9048 of the vehicles were foreign vehicles.

Surveys in Berlin, 6 cities in the Ruhr and Stuttgart have shown compliance rates of 95% to 99% for passenger cars and 85% to 93% for commercial vehicles (lorries and vans).

Compliance rates can be monitored at any time, and is useful to monitor as both assessment as to whether more enforcement is required and input into estimates of the effectiveness of the LEZ (see section 6.6). Where automatic enforcement is used, compliance rates can be permanently assessed, as shown in Figure 8 for London, which shows the 'early compliance' that occurs before the LEZ actually starts, as vehicle operators plan for the LEZ.

**Figure 4. Berlin penalties issued for vehicles without a sticker**




| | 2930 Feb. 08 | 1248 Mrz. 08 | 1144 Apr. 08 | 1017 Mai. 08 | 930 Jun. 08 | 1198 Jul. 08 | 1693 Aug. 08 | 1121 Sep. 08 | 832 Okt. 08 | 769 Nov. 08 | 667 Dez. 08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| auswärtige Kennzeichen | 3863 | 5686 | 7435 | 8841 | 10027 | 11686 | 14206 | 15994 | 17118 | 18220 | 19145 |
| ruhender Verkehr | 7003 | 9476 | 11625 | 13307 | 14738 | 16658 | 19450 | 21514 | 22846 | 24082 | 25175 |
| fließender Verkehr | 437 | 616 | 814 | 906 | 954 | 1010 | 1081 | 1158 | 1201 | 1306 | 1357 |
| Bußgelder monatlich | 7440 | 2652 | 2347 | 1774 | 1479 | 1976 | 2863 | 2141 | 1375 | 1341 | 1144 |
| Bußgelder auswärtige Kennzeichen monatlich | 3863 | 1823 | 1749 | 1406 | 1186 | 1659 | 2520 | 1788 | 1124 | 1102 | 925 |
| Einsprüche monatlich | 13 | 90 | 91 | 94 | 53 | 62 | 34 | 38 | 48 | 64 | 62 |

Key: Anzahl Bussgelder= number of penalties.

| |
|---|
| Non-Berlin number plates |
| stationary vehicles (enforced) |
| travelling vehicles (enforced) |
| monthly penalties |
| monthly penalties from vehicles registered outside Berlin |
| monthly complaints/ stated refusals to pay because of xyz reason |

**The Netherlands**

The higher compliance rates in Amsterdam compared with other Dutch cities (see section 6.4) gives an indication of the impact of camera vs manual enforcement – although manual enforcement can be implemented very variably, as discussed below. It is also noted in the Amsterdam experience

that higher compliance may not lead to cleaner vehicles if it leads to more exemptions being granted (see section 6.4).

The Dutch compliance information in the list below is from several sources from pre-2010, and those with exemptions will count as complying here:

- Amsterdam: €0.5m in LEZ fines in 3 weeks in September/October 2009. Three thousand lorry drivers were fined €150 since the commissioning camera enforcement, 150 out of the 7000 vehicles a day travelling into Amsterdam are fined. Pre-camera enforcement was 30 vehicles a day.

Before camera enforcement:

- In Den Bosch 83% of lorries complied – up from 70% from earlier monitoring
- In Eindhoven 91% of vehicles complied in June 2009.
- Tilburg over 85% compliance in October 2009, 77% the previous year. Pre-Euro 2 lorries reduced from 6% to 0.6%, Euro 2 & 3 with DPF increased from 23% to 39%, Euro 4 & 5 increased from 39% to 43%.
- Breda 77% compliance (June 2009)
- 's-Hertogenbosch (Den Bosch) 80% compliance (June 2009)
- Eindhoven 90.5% compliance (June 2009)

An NGO called Milieudefensie periodically do spot-checks on the LEZ enforcement rate, and says more needs to be done. From January 2009 they observed 20% of lorries not meeting the Euro standards set for the LEZs (irrelevant of exemption). 14 out of 24 in Maastricht's industrial access road LEZ (no longer in operation as of 2009, but changed to a town centre LEZ), 33 out of 100 in Rotterdam, 43 out of 150 in Utrecht, 16 out of 44 in Breda, 12 out of 38 in Tilburg, 20 out of 74 in Eindhoven.

The 2009 Dutch monitoring report found that compliance had improved between 2009 and 2008. In the second half of 2008, some 60-75% of the HGVs complied. In the first half of 2009, this was 80-85%. More enforcement staff were used and more checks carried out, as well as more cities moving to camera enforcement. Key was the increased perception of the chance of being caught. There were also fewer exemptions possible. Full compliance would give up to an ***additional*** 0.1µg/m$^3$ for $NO_2$ and 0.05µg/m$^3$ for $PM_{10}$.

### 4.5.3. Foreign vehicles

Enforcement of foreign vehicles is not straight forward. With manual enforcement foreign vehicles can be required to have the same sticker as the national vehicles. Where manual enforcement is used, the foreign vehicle can be issued with a penalty notice there and then, reducing the need to track down the vehicle. Where camera enforcement is used, LEZ authorities are allowed by EU law to ask foreign vehicles to register, as the foreign vehicles emissions standards are not on the national vehicle database used for national vehicles (as done in London).

There is currently no EU-wide access to vehicle data (eg Emissions standards, vehicle age, keeper details) or enforcement of non-criminal or minor traffic offences. There are currently four main ways traffic offences are enforced for foreign vehicles:

- Bi-lateral agreements, as exist between many countries
- Through private debt collection agencies (often for de-criminalised enforcement), for example London use Euro Parking Collection Plc
- Ereg is the Association of European Vehicle and Driver Registration Authorities. Its purpose is to stimulate data exchange between European vehicle registration authorities, with 25 members, including most EU countries and Switzerland and Norway. The necessary data interfaces, software and protocols already exist and that - in principle - checking of foreign vehicle through this system should already be possible.
- Taking the vehicle off the road or forbidding its entry is possible for *non-EU* vehicles where manual enforcement is used. A video of a Russian bus being taken off the road in

Sweden is unfortunately no longer on the web. However, in most LEZ countries non-EU do not account for many of the foreign vehicles.

- As stated above it is acceptable under EU law to require foreign vehicles to register with the LEZ authority.
- Through police methods (for more serious criminal enforcement, not usually included for LEZs)

EU action is the best way for this to be improved. EU action/support for enforcement of LEZs has been called for years. An EU law to allow cross border enforcement for a limited number of criminal offences is in preparation. Future reviews of this legislation, once it is agreed, may enable LEZs to be enforced cross-border.

Enforcement will be easier with larger fines and bi-lateral agreements. With manual enforcement, it is easier to identify the vehicle operator without access to the (foreign) vehicle register database. In LEZs such as London, where the fines are significant, debt collection agencies may have helped more than for an LEZ with lower fines. For the London LEZ, around 20-40 penalty notices are paid each week by foreign vehicles. In Germany, with a €40 criminal fine and a point on the licence, this is not as yet as easy. In Berlin, most of the penalties are from residents outside Berlin (see Figure 4), some of which will be foreign vehicles. This would not be unexpected, as Berlin residents need to enter the LEZ more regularly, so will try to comply or gain exemptions.

The emissions standard of foreign vehicles are usually identified either by the Euro standard on the vehicle papers, or if this is not available by the age of vehicle – unless the vehicle operator produces evidence that the vehicle meets an earlier Euro standard. This is set out formally for example in the case of Germany[19].

### 4.6. Political aspects

LEZs cannot be implemented without politicians who make the decision whether or not to implement an LEZ. A leading politician who 'champions' the LEZ can make implementation *significantly* easier. Saving children and grandparents lives can be a strong positive political argument if this is focused on – which is the whole reason for implementing LEZs! On the other side, politicians can require compromises that would defer from ideal best practice, for example further exemptions, smaller or separate LEZs, later (or earlier) implementation, weaker emissions standards. These compromises may also be introduced through consultation responses. It needs to be ensured that any compromises made do not significantly endanger the effectiveness of the LEZ.

#### 4.6.1. Political experiences from around Europe

Political experience has varied around Europe, and a selection is given in this section. As stated in section 4.1, London's Mayor, Ken Livingstone (Independent/Labour), got re-elected in 2004 with one of his main promises to clean London's air with an LEZ. There has been fairly little negative reporting of the London LEZ. Ken Livingstone did not get re-elected in 2008, but the issues in the election did not focus on the LEZ, and is not seen as the reason that he did not get re-elected. The incoming (Conservative) Mayor in 2008 delayed the tightening of the LEZ to include vans from 2010 to 2012, giving the reason as the economic crisis. Boris kept the LEZ, and is, as Ken was, planning a further phase with NOx abatement, if London gets national Government support with it.

In the Netherlands (lorries only), they agreed the LEZs in a working group that included the national and local Governments and the Dutch main haulage organisations. For the hauliers, the agreement included significant grants for retrofitting for the Dutch fleet, implementation of improved logistics schemes in LEZ towns, an assessment protocol that is needed before implementation of an LEZ, and that LEZs are only in urban areas and e.g. not single roads to industrial estates.

In Germany (all vehicles except 2-wheelers) the political reaction has been mixed. Air quality measures are decided by the Länder, usually planned out by the district authorities and then implemented by the cities. This has sometimes been a cause for disagreements. For example Munich wanted to implement an LEZ, however the Land, Bavaria, did not want to. It was only after a legal challenge from a Munich resident that Munich was allowed to implement an LEZ (see section 9.2). On the other hand, an LEZ has been 'imposed' on the town of Dinslaken in Nordrhein Westfalia against the wishes of the towns Mayor. Other examples of this include Halle (Saale), where the

19 See http://www.lowemissionzones.eu/countries-mainmenu-147/germany-mainmenu-61.

Land (regional government, Sachsen-Anhalt) has decided that the town needs to implement an LEZ, but the Mayor of Halle is trying to resist. In Freiburg-in-Breisgau the LEZ was required to be implemented by the Land (Baden-Württemberg) against the wishes of the Mayor, and the Mayor is not giving resources to enforce the LEZ, but giving large numbers of exemptions to trade operators (Handworkers). The Länder are responsible to the EU Commission for meeting the EU limit values, which often explains why they wish to implement LEZs. The Mayors who are not threatened with the EU fines, but are with potential resistance from their voters, which may explain more of their resistance.

The following bullet points give some of the aspects observed.

- In some cases like Berlin it has generally been positive. However, public opinion and newspaper articles are often driven by negative reporting and the complaints of the business and transport industries. The fact that air pollution is sometimes worse than before the LEZ due to weather conditions - but measurably better than it would have been without the LEZ – does not help.
- In Germany, the ADAC (l'automobile club) and the trade bodies (such as the IHK, Industrie- und Handelskammer) have been particularly negative towards LEZs. The ADAC has tried to take a number of LEZs to court, and has not yet been successful. The ADAC also produced a report, incorrect and based on poor science, stating that LEZs had no impact on air quality. The IHK has influenced a number of LEZs to have more exemptions or different areas than otherwise planned. Needless to say, pressure from interest groups influences politicians. In some cases the politicians say that they have no choice but to implement due to rules from Europe.
- In Baden-Württemberg Land, LEZs were not a popular option with politicians or officials at the outset, but were implemented as no other option was seen to improve air quality. However, the tone of post-implementation press releases has been more positive.
- In other Länder (regional governments) the difference splits down party lines, with the Conservatives (CDU) and Conservative-Liberals (FDP) often being against LEZs, the Socialists (SPD) and Greens for the LEZs.
- Other Länder are still not wanting to implement LEZs, and are proposing other measures – which do not always have sufficient impact on air quality.
- Those Länder with LEZ are more likely to have gained an extension to the EU air quality limit values, which as many governments in Germany are in financial problems is a significant incentive.
- Political views on LEZs can also affect the amount of effort placed on enforcing the LEZ, and therefore its impact and credibility.

In northern Italy, where $PM_{10}$ pollution is particularly high, the north Italian regions made an agreement that they would also implement LEZs (affecting all vehicles), together with other measures for heating and financial incentives. This employed the 'safety in numbers' principle, minimising the competition potential of neighbouring regions being 'LEZ-free', and also increased political acceptance due to the fact that 'everyone's doing it'. In Italy the high number of exemptions and the often relatively short time periods (6 hours a day in the winter) of the LEZ also help acceptability – but not best practice. The lack of information dissemination has on the other hand cased negative reactions as people were penalised without knowing about the LEZ.

## 5. LEZ frameworks options

The consideration in France about LEZs is to include all vehicles, in a similar way to the German scheme. The German framework has the advantage that it can be appropriate in different sized cities, with different 'strengths', from Euro 2 diesel to Euro 4. Petrol and diesel are treated differently, as per their different emissions. Excluding only pre-Euro petrol vehicles excludes the very oldest vehicles while often allowing those on low incomes access to the LEZ with a car.

There are several considerations in adopting a framework. Two key ones are: As similar as possible to an existing framework would be more welcome with hauliers working throughout Europe. On the other hand, is an existing framework suitable for the situation, or can it be improved.

In terms of the German framework, there are a few points to note:

- In terms of $NO_2$ concentrations, which will become of more concern in future years, a Euro VI emissions standard would be useful, particularly for heavy duty vehicles. This is mainly due to the cycle-beating of heavy duty Euro V vehicles in urban areas (see section 6.3).
- The London and Danish retrofit certifications give improvements on the German certification, as discussed above (section 3.2.2).
- There is an advantage in simplicity of treating all diesel vehicles equally. However, in terms of emissions benefit, there is an advantage in stricter emissions for heavy duty vehicles.

Some aspects of other frameworks that are also useful are:

- The Dutch 'LEZ roadmap', which sets out the steps needed to implement an LEZ, including the air quality assessments.
- Information dissemination, including consultation, would benefit from being required.

## 6. Air Quality Impact

This section summarises LEZ impacts. Annex 7 gives much further detail and references for the whole section and should be consulted for any queries. Presented in this report are LEZ costs that were published before February 2010, together with the more recently published reports from London, Berlin and the Rhur area of Germany.

Except for the few cases specifically stated, data is taken from post-implementation assessments. The sources, methodologies and detail are varied, as are the LEZs assessed. Every situation and LEZ scenario needs to be treated and calculated separately. Impacts of LEZs elsewhere cannot be applied pro-rata elsewhere, due to the different fleet compositions or LEZ scenario applied etc. However, they have all reported improved air quality.

As discussed in the introduction, reduction of diesel particulates has a significant health impact than for total $PM_{10}$ and $PM_{2.5,}$ which is only reflected in a few of the impact assessments. $PM_{2.5}$, $PM_{0.2}$, particulate number and black carbon will all be more affected by LEZs than $PM_{10,}$ due to the higher proportion of exhaust emissions, as well as having a higher health impact – which is why they have been assessed. Black carbon also has a climate change impact. $PM_{10}$ and $PM_{2.5}$ concentrations are more affected by regional concentrations than $NO_2$, $PM_{0.2}$ or black carbon.

Noise, traffic reduction and $CO_2$ have not been reported as changing significantly with LEZs. Traffic reduction is more likely to occur for LEZs aimed at cars, but in practice traffic reduction has not been observed. The main exception is the Milan combined congestion charge-LEZ, which aims to reduce both traffic and pollution and therefore has had these two impacts. There is evidence of fewer cars registered from Munich, which may suggest less traffic, and may be the case elsewhere, but this has not been specifically reported. This could also be due to other causes such as the economic situation in 2009.

The emissions standard, vehicles affected and size of the LEZ zone implemented will affect the impact. The underlying air quality situation also plays an important role in the air quality impact.

There are four ways in which air quality impacts have been assessed, each with their pros and cons:

- **Air quality monitoring:** enables the 'actual impact' to be measured – but at specific sites. The impact of weather and non-LEZ measures need to be accounted for – often by comparing monitoring inside and outside the LEZ. However, areas outside the LEZ are also affected by the LEZ, as cleaner vehicles travel into the LEZ. Other factors, such as measures to improve air quality or large building sites are also often difficult to separate – however can usually be identified and noted in the assessments as to how to interpret the results. Non-LEZ air quality improvement measures may well also apply equally outside the LEZ, and large building sites near monitoring stations should be known by those assessing the LEZ. Monitoring assessments will become more robust with years since implementation, as the impact of the weather averages out.

- **Air quality or emission modelling:** is weather-neutral, but relies on emissions factors as well as an estimated vehicle fleet. The air quality modelling results are, however, validated against monitoring data, so reducing *some* of the uncertainties. Emissions factors are estimates based on vehicle measurements and are a key uncertainty. For example, those of later Euro standard vehicles that have not been tested under emissions factor programs, which are often based on the anticipated reduction in emissions from the Euro standard, however this reduction is not necessarily always delivered in real-life urban driving conditions – see section 6.3.
- **Vehicle emissions testing:** this tests vehicles of different emissions standards and retrofitting (with vehicles on dynamometers or instrumented vehicles on-road) under situations simulating 'real life'. The outputs are needed to provide emissions factors and can assist in policy-making.
- **Fleet composition:** the Euro standard and retrofitting of vehicles registered or observed travelling in the LEZ, compared with a 'business as usual' scenario or the national fleet can be assessed. This is the impact of the LEZ, which in turn leads to air quality improvements.

### 6.1. Air Quality Results

The tables below summarise the results from the many different assessments and are discussed in the following section. The data reported in both of the tables below give results for the 'LEZ-only' effects. Unless stated, the time period taken is a year.

In summary:

- All LEZs have reported an increased proportion of higher Euro standard vehicles and fewer earlier Euro standard vehicles.
- All LEZs have reported air quality improvements. The magnitudes have varied, as one would expect, due to different emissions standards, vehicles affected, fleet composition, compliance, exemptions, meteorology, topography of the different cities.
- With purely air quality monitoring data, reductions in $PM_{10}$ daily average from 13% to 0%, $PM_{10}$ annual average from 12% to 0%, black carbon 11-50%, the one assessment with $PM_{2.5}$ gave 15% for local concentrations. $NO_2$ concentrations range from 1.5% to 10%.
- The assessments using modelling gave reductions in $PM_{10}$ exceedences[20] from 5% to 20%, $PM_{10}$ annual average from 0.2% to 10% (0.02 to 0.7µg/m$^3$), $PM_{10}$ emissions from 2% to 40%, $PM_{2.5}$ concentration from 3.5-4.5% (0.7µg/m$^3$), traffic PM/$PM_{2.5}$ of 4% / 2.4%, $PM_{0.2}$ concentration between 2.5% and 9%, black carbon 15% and diesel PM 4% to 58%. $NO_2$ concentrations range from a change of +8% to -10% (0.02 to 4µg/m$^3$), $NO_x$ emissions from -0.05% to -20%.

Except for London, the only assessments with purely air quality monitoring data (independent of emissions factors) are for LEZs that affect both light and heavy-duty vehicles. Where figures are in brackets together with a word, then this figure relates to the change attributed to that source (e.g. (traffic) means as a proportion of the traffic-related pollution). Where entries are in grey, there more recently estimated figures are also available.

In all cases, the assessments will get more robust with time, as the differences due to weather are averaged out. Those modelled assessments with less than one year are subject to particular uncertainty.

In the modelling table, it should be noted that the Dutch figures take into account new $NO_2$ emissions factors, as do the Berlin and London 2010 and Rhur 2009 figures. All others do not, and therefore the $NO_2$ figures are subject to particular uncertainty. Data is also compared with implementing no LEZ, unless otherwise stated.

The data in the table below has been taken from publications of the cities, ministries or ministry environment agencies, with the exception of Munich, which was from a well-respected university researcher.

20 Refers in this document to number of days exceedence of the $PM_{10}$ EU limit values.

**Table 3. LEZ air quality improvements assessed with purely air quality monitoring data**

| City; date of monitoring; emissions standard | $PM_{10}$ daily exceedences pa | $PM_{10}$ annual average concentration | $NO_2$ concentration | Black carbon concentration | $PM_{2.5}$ concentration |
|---|---|---|---|---|---|
| **Berlin; 1.1.08; E2(PM) diesel, E1 petrol**[a] | No impact identified | No impact identified | 6-10% | 14-6% (11-3%)[a] | |
| **Berlin; 2010; (E4(PM) diesel, E1 petrol** | Up to 10 exceedences, 20% | cf 2009 0-2 µg/m$^3$, 0-5% | ~ 5-12% | (traffic 50%) | |
| **Cologne; 1.1.08; E2(PM) diesel, E1 petrol** | 10 exceed.[b] | 2µg/m$^3$, 7%[c] | 0.7µg/m$^3$, 1.5% | | |
| **Ruhr area; 1.10.08; E2(PM) diesel, E1 petrol**[c] | '3-4% | '-2-4% | | | |
| **Baden-W; 3.2008+; E2(PM) diesel, E1 petrol** | Reductions in 22 out of 29 monitoring sites[d] | | Marginally decreased | | |
| **Hannover; 1.1.08; E2(PM) diesel, E1 petrol** | 1-2% | | 5% | | |
| **Munich; 1.10.08; E2(PM) diesel, E1 petrol** | In LEZ 5.4 to 12.3%<br>Ring road +3.9 to 8.9%<br>Outside 0%[e] | | | | |
| **Bremen; 1.1.09; E2(PM) diesel, E1 petrol** | 6% | | 6%[f] | | |
| **London; 2010; E3(PM) HDV** | Not yet able to quantify specific contribution, but supported $PM_{10}$ reductions observed | | Not yet able to quantify specific contribution | 40-50%[h] | (local 15%), 1µg/m$^3$ |
| **Milan; 2008;** [i] | 13% | 4% | | | |
| **Rhur area; 2009 cf 2007; E2(PM) diesel, E1 petrol**[j] | 16 exceedences | 2.1-2.4 µg/m$^3$, 7% | 1.2 µg/m$^3$ | | |

[a] the meteorological conditions in 2008 were more stagnant than in 2007, which helps indicate that improvements as being from the LEZ as opposed to different weather. The first black carbon figure is including natural vehicle turnover, the second is with an estimate for this taken off.

[b] also affected by building work, 2009 data should clarify these changes.

[c] early estimates from monitoring data

[d] meteorological factors also contributed. This means reductions of varying magnitude in the measurements at 22 out of 29 monitoring sites.

[e] reduction of half-hour averages used over 4 months compared to the background reference-monitoring site outside the LEZ (hence outside is 0%). The + indicates an increase in pollution at one point on the ring road (the other is also reduced). Absolute changes and explanations are given in Annex 7.

[f] one monitoring site

[h] total reduction mid 2006-end 2009 from the two black carbon monitoring sites, a significant part is from the LEZ

[i] congestion charge cum LEZ scheme, emissions standards are complicated – see section 3.2.6.1. All vehicles except motorcycles are affected, cleaner vehicles are not charged.

[j] similar air quality years before and after implementation of LEZs in the Rhur area, comparing air quality stations in and outside the LEZs.

**Table 4. LEZ air quality improvements assessed with modelled air quality data**

| City; date of monitoring; emissions standard | $PM_{10}$ daily exceed. pa | $PM_{10}$ annual average concentration | $NO_2$ concentration | $PM_{10}$ emissions | $NO_x$ emissions | $PM_{0.2}$ or $PM_{2.5}$ concentration |
|---|---|---|---|---|---|---|
| **Berlin; 2008; E2(PM) diesel, E1 petrol** | From 28 to 24, 14% | 3% | | (traffic 24%) | (traffic 14%) ($NO_2$-relevant emis.1-10%) | 4.5% $PM_{2.5}$, 15% black carbon[I] |
| **Berlin; 2010; (E4(PM) diesel, E1 petrol** | | ~7% | | | 20% | Diesel PM 58% |
| **Baden-W; 3.2008+; E2(PM) diesel, E1 petrol** | $PM_{10}$ LVs expect to be met with action plan and time extension | | | 15% | | |
| **Hannover; 1.1.10; E4(PM) diesel, E1 petrol** | | | 10%, 4µg/m$^3$ | | | |
| **Munich; 10.08; E2(PM) diesel, E1 petrol** | up to 5 exceed | | | | | |
| **Bremen; 1.09; E2(PM) diesel, E1 petrol** | | | | 2% | 2% | |
| **Netherlands; 7.07→; E3(PM) HDVs[III]** | | 0.2 to 0.4% 0.06µg/m$^3$ [II] (vehicle 2%) | 0.2 to 0.4% 0.08µg/m$^3$ [II] (vehicle 1.5%) | | | |
| **Netherlands; 7.07→; E3(PM) HDVs[IV]** | | Over 10% 0.1 to 0.6µg/m$^3$ | 2 to 5% 0.1 to 0.55µg/m$^3$ | | | |
| **Netherlands; 2009 for 2010; E4(PM) HDVs[III]** | | | 0.1µg/m$^3$ [II] | | | |
| **Netherlands; 2013; E4 HDVs[III]** | | Remain similar | Reduce significantly | | | |
| **Netherlands; 2010 for 2010; E4(PM) HDVs** | | Roadside: 0.02-0.08µg/m$^3$ (traffic 2-7%) Roadside >LV 0.15-0.25µg/m$^3$ | Ave hardly reduced, Range +8%[VIII] to –5% | (traffic 20%, exhaust 30-35%) | Hardly reduced | |
| **Netherlands; 2010 for 2013; E4 HDVs** | | 0.02-0.07µg/m$^3$ (traffic 2-7%) | 0.02-0.09µg/m$^3$ (traffic 1-2%) Roadside >LV up to 0.3µg/m$^3$ | | | |
| **Stockholm;[V] 2000; E2(PM) HDVs** | | | | 40% 50%[VI] | 10% 20%[VI] | $PM_{0.2}$' 0.5 to 9% 0.5 to 12%[VI] |
| **Stockholm; 2007; E2 HDVs** | | | | 13 to 19% | 3 to 4% | |
| **Gothenburg; 2006; E2(PM) HDVs** | | | | 33% | 7.8% | |
| **Copenhagen; 2010; E4(PM) HDV** | | 2.5% 0.7µg/m$^3$ | 46% in area; from 65 streets exceeding to 35 | 9% ($PM_{2.5}$ -16%) | 17% (primary $NO_2$ 16%) | $PM_{2.5}$ 3.5% 0.7 µg/m$^3$ |
| **Milan; 2008;[VII]** | | | | 14% | 11% | |
| **London; 2010; E3(PM) HDV** | | ave. 0.03 µg/m$^3$ max. 0.5 µg/m$^3$ | ave. 0.12µg/m$^3$ max. 0.16µg/m$^3$ | (traffic 1.9% $PM_{10}$) | (traffic NOx 2% $NO_2$ ↑ 3%) | (traffic $PM_{2.5}$ 2.4%, traffic exhaust 4%) |
| **Rhur area; 2009 cf 2007; E2(PM) diesel, E1 petrol** | | 0.4 µg/m$^3$, 2% | 1.7 µg/m$^3$, 3% | | | |

Key: (traffic = of total traffic emissions)

[I] if in 2007, using monitoring data together with some modelling as detailed in Annex 7.

[II] average along roadsides, depends on % lorries, ranges from $PM_{10}$: -0.06-0.09µg/m$^3$, $NO_2$ -0.05-0.13µg/m$^3$. For 1200 HGVs a day reductions could be up to -0.15µg/m$^3$ for both $PM_{10}$ and $NO_2$. Full compliance could give an ***additional*** 0.05µg/m$^3$ reduction for $PM_{10}$ and 0.5µg/m$^3$ for $NO_2$.

[III] 2009 report, with impact of better emissions factors. Dutch reports are having an LEZ compared to not having an LEZ

[IV] 2008 report, impacts also expected to increase impact by a factor of 1.5-2 with better enforcement and fewer exemptions. Impact of new emissions factors has been included.

[V] enforcement has improved since, increasing impact

[VI] impact with full compliance. In 2000 when the scheme was implemented compliance was at a particularly low level. In 2008 there was around 95% compliance.

[VII] congestion charge cum LEZ scheme, emissions standards are complicated – see section 3.2.6.1. All vehicles except motorcycles are affected, cleaner vehicles are not charged.

[VIII] due to a large proportion of Euro II and III lorries with diesel particulate filters fitted (31%) and relatively few Euro IV and V lorries (with low $NO_2$).

### 6.2. Discussion of the air quality data presented

As stated above, it would be expected that the results vary from LEZ to LEZ for the reasons given. There are some particular issues that are useful to draw out of the results to explain some of the variations.

- There is a wide range in the figures presented, much of which stems from the different LEZs implemented. For example the German LEZs affect light duty vehicles which when retrofitted with a DPF reduce their primary NO2 emissions, whereas the Dutch LEZs only affect lorries.
- Estimates for the second (2010) phase of LEZs would be expected to have a more significant impact, as the emissions standards tighten.
- The frequency distributions of $PM_{10}$ daily averages at sites with high numbers of exceedences can mean that even small reductions in concentration has a larger impact on the number of exceedences of impact[21], so percentage figures here should be taken with care. Similarly for $NO_2$, relatively small changes in annual average can lead to a considerable geographic area no longer exceeding the limit value[22].
- Indications from work with Berlin and Hannover that LEZs such as those in Germany that affect cars and allow their retrofitting with DPFs are likely to have more impact on NO2 than LEZs that affect only heavy-duty vehicles. This is partially due to larger total $NO_x$ reductions from more vehicles being affected, and partially due to the retrofitting of DPFs on Euro 3 LDVs reducing their primary NO2 emissions (see Annex 7, section 20.8.2). There will also be generally a larger emissions reduction, due to more vehicles being affected and more vehicles retrofitted.
- The fact that the Netherlands is heavily affected by long range pollution may affect the impact of the LEZs.
- One would expect an LEZ in 2000 to have more impact than in 2008, as more of the more polluting older Euro standards (Euro 0, 1 and 2) were in the fleet to be affected by the LEZ. This is shown in the figures Stockholm for 2000 and 2007. The 2000 figures should no longer be seen as representative
- The Milan Ecopass, a combined LEZ and congestion charge scheme, differs from the other schemes in several important aspects that affect its impact. It reduces traffic flow and congestion, which will also influence emissions as well as the emissions of each vehicle. The Ecopass scheme charges dirtier vehicles rather than banning them (so they in theory are more likely to enter than with a traditional LEZ), although the camera enforcement may mean that this is not in fact the case. However, in Milan the Lombarida-style LEZ also operates to exclude the very dirtiest vehicles (at the time of the assessment this was in the winter only). These combination of factors means that its relative high impact on air quality is reasonable.

21 Verbessern Umweltzonen die Luftqualität? Prof. Dr. P. Bruckmann (NRW), Dipl.-Met. Martin Lutz (Berlin)

22 London LEZ feasibility studies, GLA/TfL.

- In the case of Berlin, air quality data has been used together with source apportionment, to try to isolate the impact of the LEZ from other factors, as the large agglomeration and the LEZ impact makes it hard to monitor inside and outside the zone. The data under monitoring data has been varied by the observed change in traffic flow, linearly without emissions factors.
- $PM_{10}$ and $PM_{2.5}$ are significantly affected by long range PM, whereas black carbon and $PM_{0.2}$ are not. This explains the difference between the London and Berlin figures for $PM_{2.5}$ and black carbon. Epidemiological evidence currently suggests that all $PM_{10}$ has a negative health impact. However, the smaller the particulate, the more harmful it is to health ($PM_{10}$ being on the large end of the range, compared with, for example black carbon and $PM_{0.2}$), and black carbon of more concern than many other components.
- The geographical representation of the results depends on the assessments done. Air quality monitoring data will be for the monitoring sites used, which are chosen to be representative. The modelling work used for the assessments usually takes a number of representative streets for the change in air quality, although some such as the Stockholm 2000 assessment is the range from area-wide modelling.
- London hope to reduce the increase in $NO_2$ concentrations observed by 1) changing the retrofit certification to reduce the $NO_2$ increase allowed and 2) hoping to implement a NOx abatement stage of the LEZ.
- Different methodologies, predictions and emissions factors are used, and there will also be differences in what is accounted for in the different assessments, particularly for the modelling assessments. For example in Denmark, Berlin and Hannover changes in primary NO2 is specifically accounted for, in others this may be the case, but this has not been specifically highlighted in the reports. The Netherlands and Stockholm in 2000 specifically account for compliance rates and exemptions, others may also do this, but again this has not been specifically highlighted in the reports.
- Emission testing suggests there is less NOx emissions reduction from Euro 3 and 5 vehicles than expected, particularly for HDVs and cars, although the impact is still positive. This is particularly for Euro V heavy duty vehicles in urban driving (often known as cycle-beating, see section 6.3). This explains the lower than expected reductions in $NO_2$ in the Netherlands, together with the increased primary $NO_2$ from some diesel particulate filters on heavy duty vehicles, and that the predicted figures did not take into account exemptions or less than 100% compliance rates.
- Newer NOx emissions factors that take into account the cycle-beating were used for the more recent Berlin, London and Dutch work. The older Dutch figures have been altered to account for these altered emissions factors, as per the advice given. However, this is not possible with other assessments, as there is no advice on how to alter assessments, which depends on the specific emissions factors used. This uncertainty would suggest that generally more emphasis might be placed on the assessments using monitored air quality data than those using modelling.
- Air quality improvements from the Dutch LEZs have also been reduced by the number of exemptions (giving a 50% reduction in lorries not meeting the emissions standards as opposed to 100%).
- The fact that monitoring and modelling assessments, using completely different methods, when both are available, usually give generally similar results gives support and some sensitivity testing to the assessments.

### 6.3. Emissions testing

Three studies are particularly relevant to the $NO_x$ impact of LEZs, summarised here, and further information and references in Annex 7:

- Work by the Dutch MINVROM using realistic driving cycles suggests that the urban $NO_x$ emissions factors for Euro 3 and 5 HDVs are less than previously thought. Euro 5 urban emissions factors increased from 3.5g/kg$CO_2$ to 10g/kg$CO_2$, Euro 3 from 8-9g/kg$CO_2$ to 13g/kg$CO_2$. This will reduce the impact of LEZs from what could be expected from the Euro standards themselves.

- The Hannover LEZ had a legal challenge based on the claim that the LEZ impact on $NO_2$ would be negative due to retrofitted DPFs increasing primary $NO_2$. Studies by Berlin and Hannover found that phase 2 of the LEZ would have a positive impact on $NO_2$ due to three factors combine to make give a positive impact of the LEZ over Business as Usual (BAU) on $NO_2$-impacting emissions, with even the worst assumptions:
- DPFs fitted to Euro 3 LDVs reduce primary $NO_2$ by 30%,
- $NO_2$-neutral retrofits are recommended for 60% of HDVs
- the LEZ reduces $NO_x$ emissions by 10%.
- business as usual gives a maximum of 6% reduction, the LEZ 6-16%, depending on the scenario.
- Dutch TNO research that says van LEZs are effective for $NO_2$ from Euro 4 – agreeing with the Hannover/Berlin work above.

### 6.4. Vehicle fleet impact

All LEZs have shown an impact on the vehicle fleet, with an increased proportion of vehicles with lower emissions. An overview of the impact on the vehicle fleet is given here for the three most recent studies, London, Berlin and the Netherlands.

In the **Netherlands**, the percentage of lorries meeting the emissions standard (Euro 4(PM)) has increased from 52% without the LEZ to 75%, the proportion of vehicles meeting the standards ranging from 20-30% in the different cities. One third of the vehicles not meeting the emissions standards had exemptions. On average 16% of the lorries in the LEZ are driving illegally in the LEZ, although this varies between cities, depending on the enforcement method. Only 5% of lorries in Amsterdam, with camera enforcement, drive illegally and 20-25% in 'S-Hertogenbosch, Eindhoven and Breda which use manual enforcement. The better enforcement has not necessarily led to a cleaner fleet, as in Amsterdam more exemptions (either 12 days a year or annual) have been claimed. Increased enforcement has improved the acceptability of the LEZ, as all are seen as being treated fairly, and with fewer exemptions allowed would have led to a cleaner fleet. Public vehicles and buses are not covered by the LEZ, and in some cities around 15% of the municipal fleet do not meet the LEZ standards, and in Amsterdam many of the buses will only comply in 2012. This could well also impact on the air quality impact of the LEZ.

Figure 5 below shows the different vehicle categories of vehicles in the LEZ in Berlin. It shows that there is an increase of cars with green stickers by a factor of 1.5 compared to without an LEZ, and for lorries of a factor of 3.

**Figure 5. Berlin's improved vehicle fleet with LEZ**

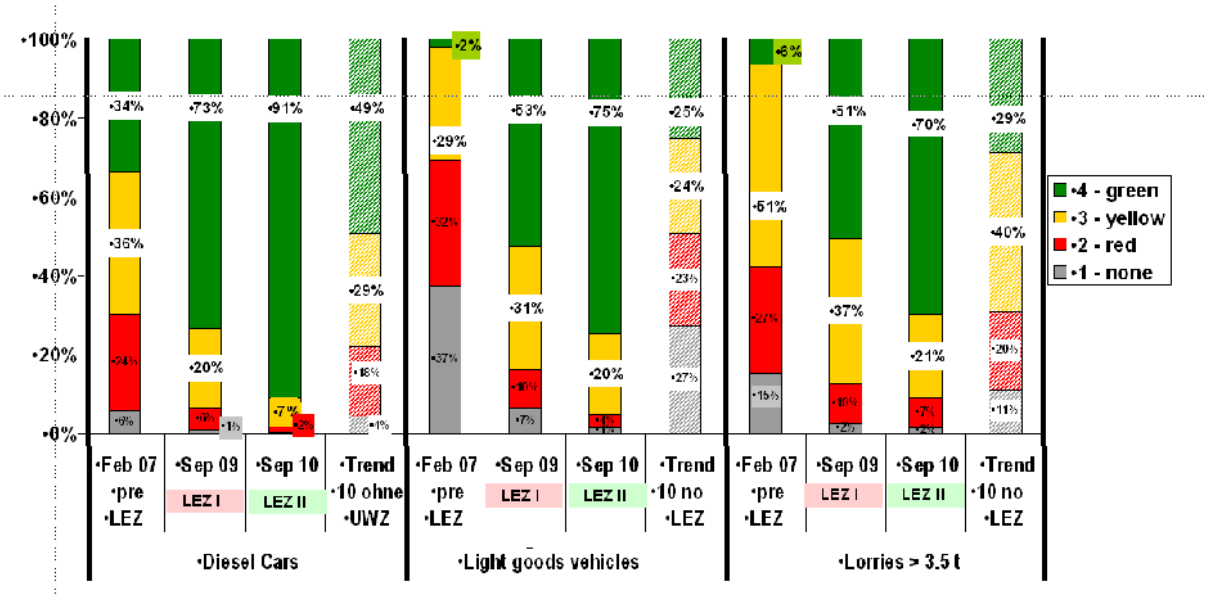
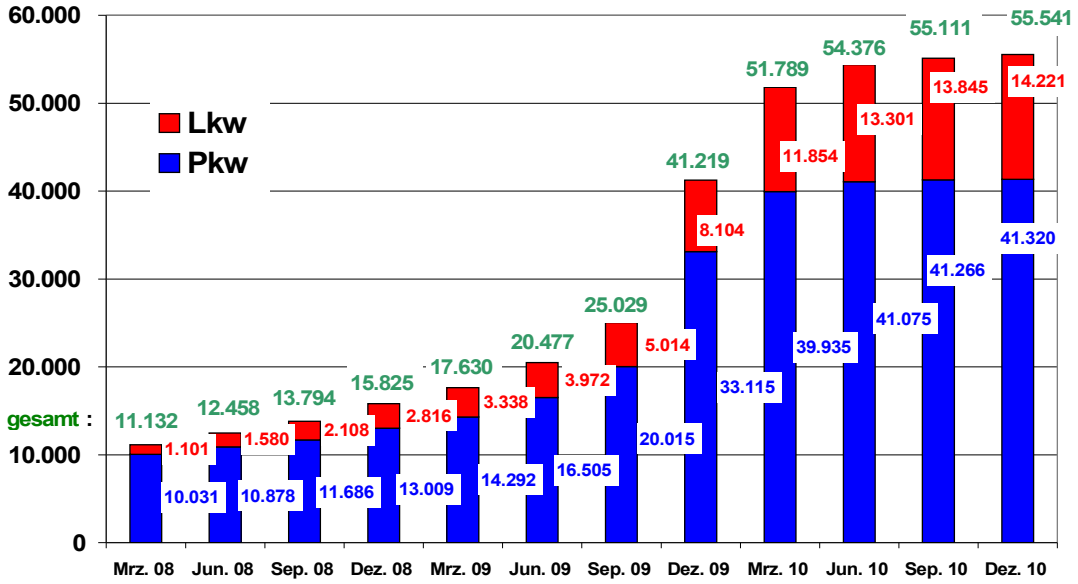


**Figure 6. Diesel particle filter fitting in Berlin's vehicle fleet**




Key: Lkw = lorry, Pkw= cars, gesamt=ltotal. Mrz=March, Dez=Dec.

In **London**, where enforcement is with cameras and high penalties, compliance is 98% for articulated heavy goods vehicles (over 7.5T, phase 1) and 96% for rigid heavy goods vehicles (between 3.5 and 7.5T, phase 2). Compliance started before the implementation of the LEZ, and can be see in diagrammatic form in Figure 7, and actual compliance in Figure 8.

**Figure 7, General nature of LEZ impacts on emissions performance of vehicles**

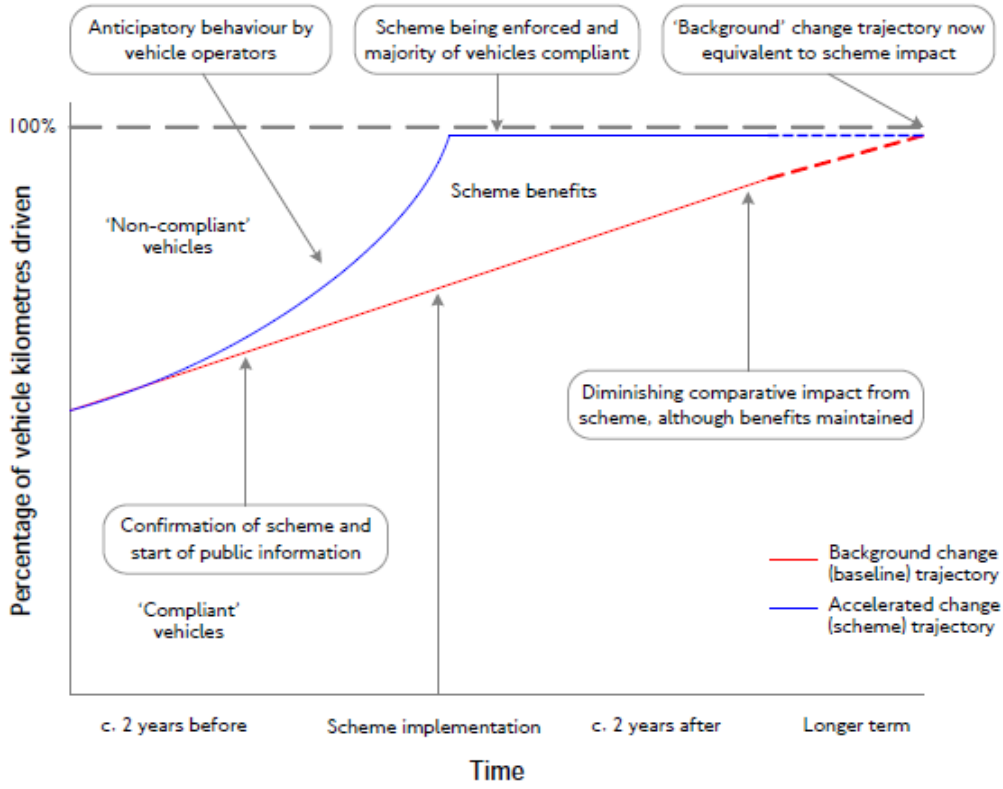


**Figure 8. Trend in vehicle compliance (% of vehicles observed in LEZ) for phases 1 and 2**

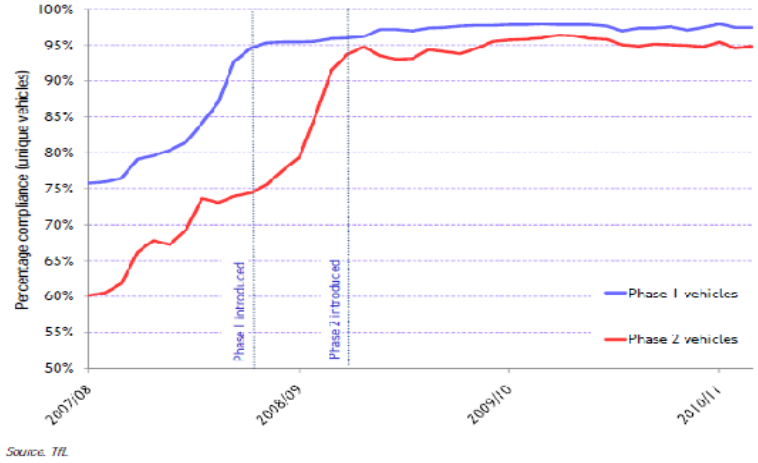
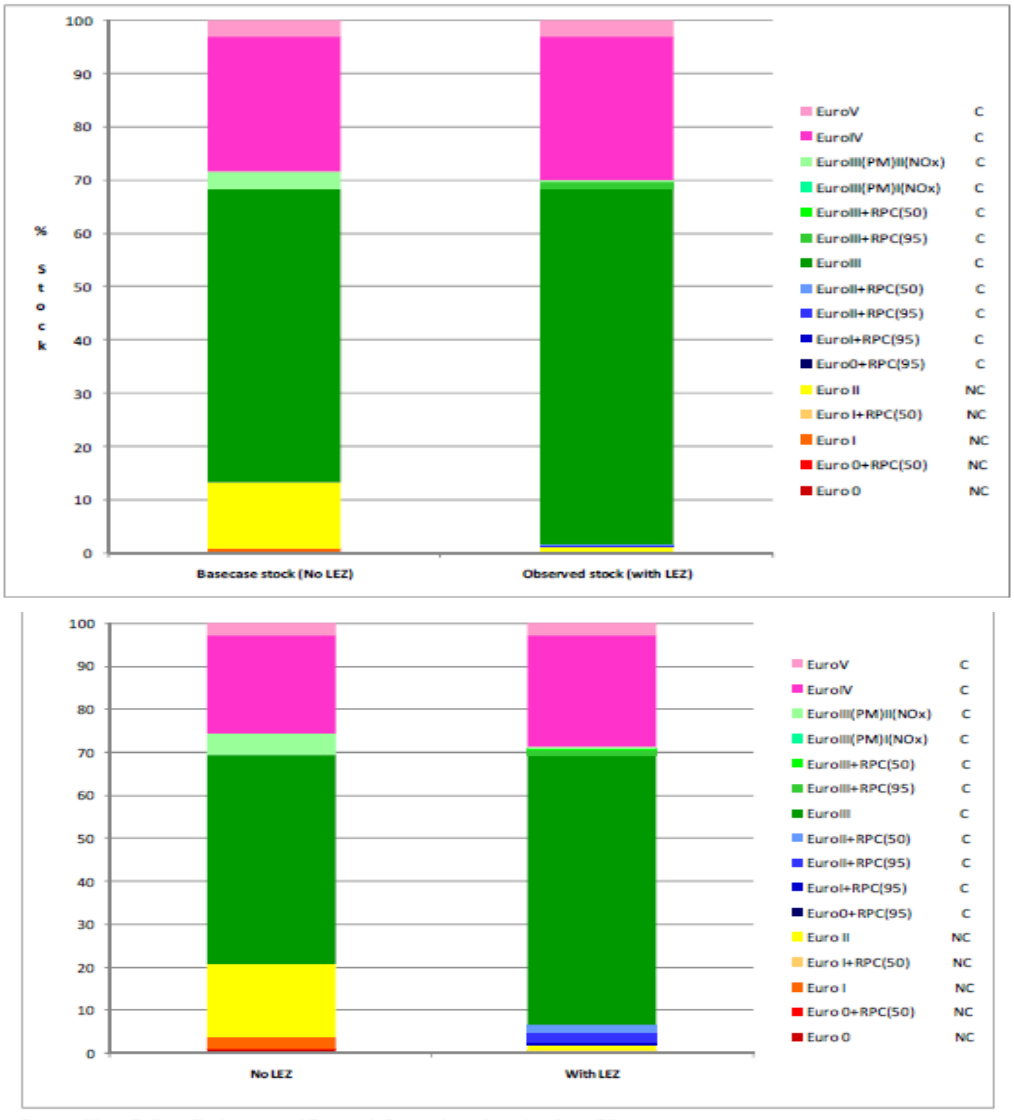



**Figure 9. LEZ phase 1 - before/after Euro Class profile of vehicles in London.** Top articulated heavy goods vehicles, bottom rigid heavy goods vehicles.




*Source: Kings College Environmental Research Group, based on data from TfL.*

### 6.5. Meeting the EU Limit Values

LEZs have always been implemented as a part of a package of measures. They are not a 'magic bullet', but often the strongest of the local measures implemented as part of a package of measures. LEZs are also one of the measures that the EU requires to be considered when Member States apply for extensions to the EU LVs[23].

In many cities and countries, LEZs together with comprehensive air quality action plans have enabled the air quality limit values for PM to be predicted to be met by the extended deadline, and an extension to be granted. In terms of meeting the EU limit values, it is this package of measures that has demonstrated compliance rather than the LEZs alone. The Netherlands have also obtained this for $NO_2$ on the same basis. Implementing an LEZ alone does not guarantee an extension, for example if compliance is not demonstrated or all required measures are considered[24].

### 6.6. Air quality assessment methodologies

These are varied, and depend on the data available and also on the specific details of the cities involved. The data availability issue explains why it is wise to consider assessment in the set-up and preparation of the LEZ, also to ensure that measurements are taken before the LEZ was implemented as well as afterwards.

Consideration of which pollutants are included is wise to ensure that at least $PM_{10}$, $PM_{2.5}$, black carbon, particle number, $NO_2$, and NOx or NO are included in the assessments. Roadside ozone may also be useful to help investigate primary $NO_2$ issues, and black soot measurements can be related to black carbon measurements with known relationships. Black carbon is particularly useful, as it is a) the portion of PM that is most closely linked to negative health effects, b) a key emission primarily from (particularly diesel) road vehicles (affected by the LEZ) and c) is less affected by long range pollution than $PM_{10}$ or even $PM_{2.5}$. There is a significant advantage to using both monitoring and modelling methods – sometimes in combination. There should be both background and traffic monitoring sites, the traffic sites having high flows for the vehicles affected by the LEZ. Achieving these monitoring stations may be possible by adding pollutants to existing stations, or if needed adding new monitoring stations. London is the only LEZ city that is known to have added an additional monitoring station to monitor the LEZ, and also added additional pollutants at existing sites. Many LEZ cities are not able to do this, and make the best use of existing monitoring sites.

There are several key (good practice) methods used to assess LEZs:

(a) Modelling (air quality and emissions) the impact of the LEZ, compared to a scenario without the LEZ implemented ('business as usual').

- Advantages: area-wide and give easy comparison with and without LEZ
- Disadvantages: reliant on emissions factors and other estimates

(b) Comparing (averaged) air quality monitoring data inside the LEZ with comparable monitoring sites outside the LEZ.

- Advantages: relatively simple method, takes out the impact of national measures
- Disadvantages: requires appropriate sites, and sufficient sites. Difficult in very large (incomparable) cities, such as London, Berlin and Paris. These other sites may also be affected by the LEZ, as compliant vehicles also travel in these areas, so will give an underestimate

(c) Comparing trends

- Advantages: relatively simple method
- Disadvantage: not so detailed as some other methods

(d) Using source apportionment to determine where the different particles come from, to then use this with concentration reductions to be able to ascribe (link) these to the traffic and therefore the LEZ

- Advantage: can be used in large (incomparable) cities

23 ANNEX XV, DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

24 http://ec.europa.eu/environment/air/quality/legislation/time_extensions.htm

- Disadvantage: requires a detailed source apportionment study

(e) Emissions standards (and therefore also compliance) of vehicles entering the LEZ (before and after implementation)

- Advantage: is needed for modelling, and is the direct impact of the LEZ. Also useful to help analyse the air quality data, due to for example early compliance.
- Disadvantage: does not necessarily relate to emissions or air quality improvements, but requires emissions factors to do so

(f) Traffic flow by vehicle type, preferably vehicle speeds, needed for the emissions estimates and interpreting the air quality monitoring measurements.

(g) Statistical procedures, for example those that provide 'meteorological normalisation' (attempting to remove variability attributable to climatic variation from the trend); remove, so far as possible, the influence of variability from non-local pollution sources; or identify the traffic proportion of the measurement.

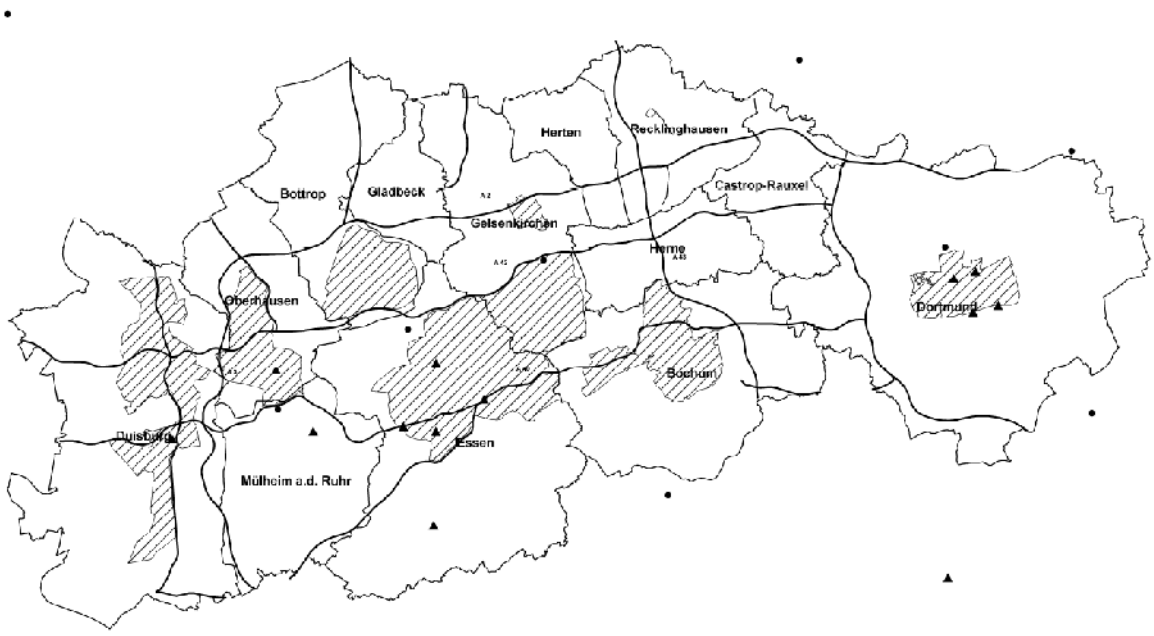
- Advantage: Enable assessment of the LEZ
- Disadvantage: Complex

The following sections outline some of the methods used in more detail, except items (a), (e) and (f) which are fairly standard. More information on many of these can be found in the air quality Annex 7, section 20.

### 6.6.1. Comparing air quality monitoring data inside and outside the LEZ

Where there are a large number of monitoring sites around a number of comparable cities, comparing air quality monitoring data inside and outside the LEZ can be a useful method. This relies on sufficient and comparable monitoring sites, and as the monitoring sites outside the LEZ are also likely to have the cleaner vehicles travelling through them, is likely to give an underestimate. This method can also be used in more spread-out similar cities, as long as there are similar non-LEZ activities occurring in each city and the weather/topology is not significantly different.

**Figure 10. Monitoring stations in the Rhur area**




Key: shaded area = LEZ, ▲= traffic monitoring sites ● = background monitoring sites.

**Table 5. Comparisons for Rhur area $PM_{10}$ concentrations**

| Monitoring site type | Number of monitoring sites | Change 2009-7 | |
|---|---|---|---|
| | | Annual average | Number of exceedences |
| Background Nordrhein-Westfalen (NRW) | 27 | -1.1 µg/m3 | -3 |
| Traffic site, NRW outside LEZ | 3 | -0.8 µg/m3 | -3 |
| Traffic site Rhur area inside LEZ | 5 | -3.2 µg/m3 | -19 |
| Traffic site Rhur area outside LEZ | 1 | -1.3 µg/m3 | -5 |

### 6.6.2. Ratios of changes

If the impact of the LEZ was zero, the ratio between the averaged background monitoring sites from 2004-7 over the averaged background monitoring sites from 2008 should be the same as the averaged traffic monitoring from 2004-7 over the traffic-monitoring site for 2008. However, if this is significantly different, and the major traffic air quality measure in the area was the LEZ, then this difference can be attributed to the LEZ. Hannover provides an example of this method being used (see section 20.1.5).

### 6.6.3. Using source apportionment together with monitoring data

A source apportionment of $PM_{10}$ or $PM_{2.5}$, this can identify its different sources. While absolute concentrations of pollutants strongly depend on the meteorological conditions, the relative contribution of the source sectors should be less prone to weather changes. Black carbon is also less affected by regional influences.

Figure 11 shows a source apportionment from Berlin for $PM_{10}$, with the different source categories that can be assessed. Figure 12 shows a $PM_{2.5}$ source apportionment, aggregated into the relevant sources for LEZ impacts. The source apportionment in Figure 12 can then be used together with the monitored black carbon concentration reductions to identify what proportion of this can be attributed to the LEZ, and therefore the reduction in $PM_{2.5}$ or $PM_{10}$ that can be attributed to the LEZ. Further details of the Berlin assessment can be found in sections 20.1.1 and 20.1.1.

**Figure 11. $PM_{10}$ source apportionment from Berlin**

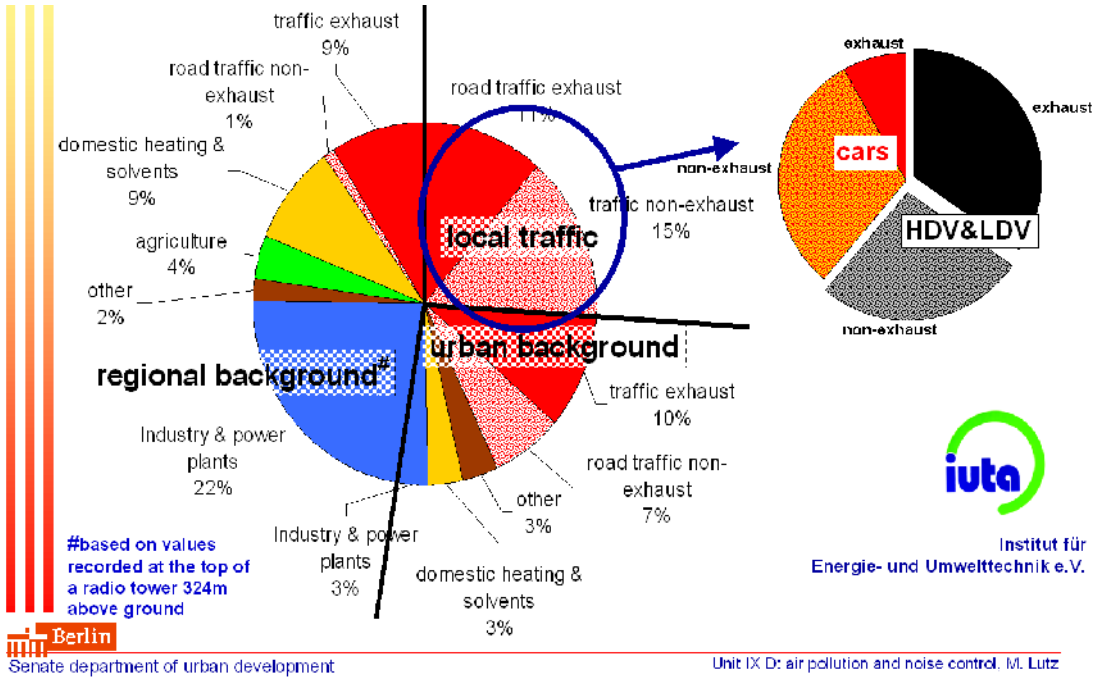
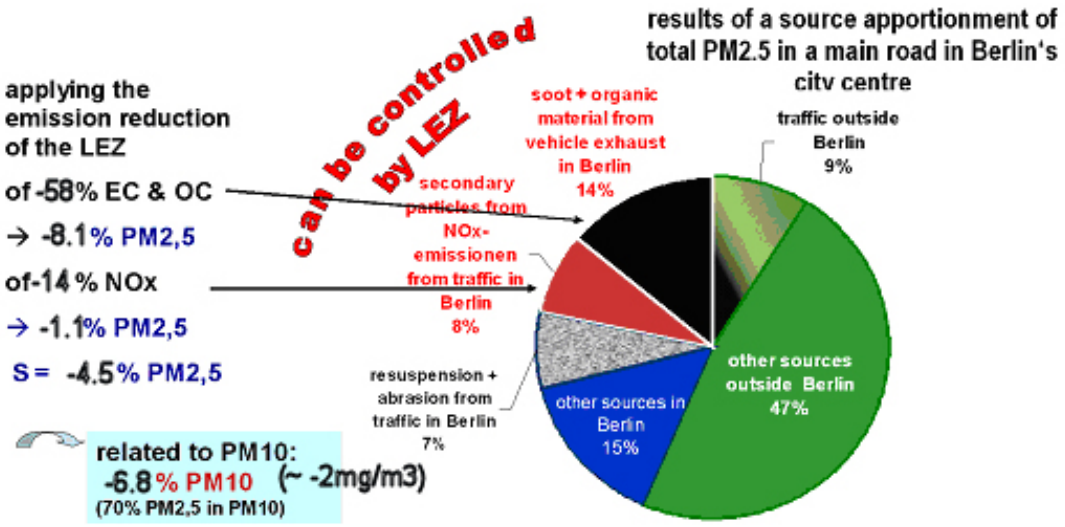


**Figure 12. Estimation of the LEZ impact on $PM_{2.5}/PM_{10}$ by applying the calculated LEZ-related emission reduction traffic exhaust $PM_{2.5}$**




### 6.6.4. Statistical procedures

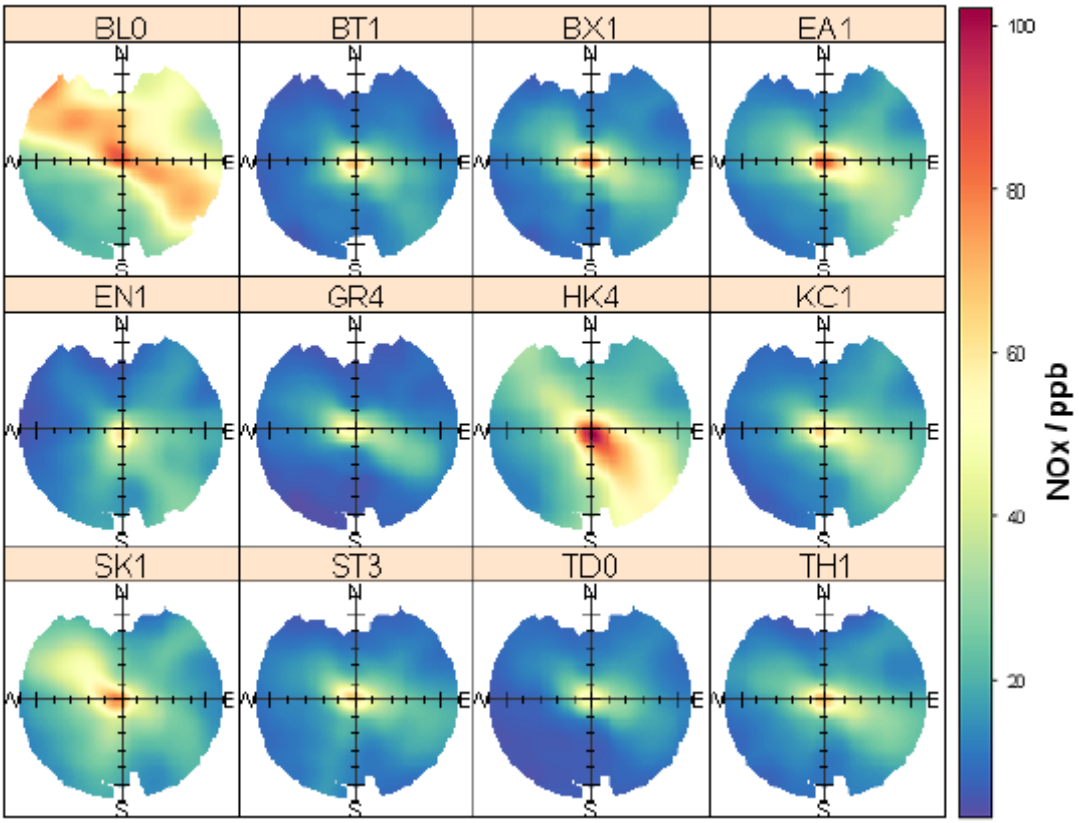
The statistical procedures are the most complex methods used. 'Meteorological normalisation' (attempting to remove variability attributable to climatic variation from the trend) and removing the influence of variability from non-local pollution sources – are used to assess the London LEZ by the Environmental Research Group at Kings College London.

'Meteorological normalisation' is a particularly complex procedure, outlined in a paper by David C. Carslaw and Paul J. Taylor in Atmospheric Environment 43 (2009) 3563–3570. Removing the influence of non-local pollution sources is done by selecting appropriate background air quality monitoring sites and then using these to take the non-traffic pollution from the traffic monitoring site data. Figure 13 shows polar plots for London background monitoring sites for NOx, and the same can be done for $PM_{10}$. It can be seen that plots BL0, HK4 and SK1 while identified as background sites, have significant local sources, and are therefore not appropriate for using for this method. Averages of the others, or of those surrounding the relevant traffic monitoring site, can be used to subtract the non-local traffic pollution from the traffic monitoring sites.

Identifying the traffic proportion of the measurement has been used in Berlin, and involves factoring black carbon concentrations by the percentage change in traffic – giving an emissions-factor independent change.

Statistical data such as the number of days with low wind speeds or without rain, or Radon concentrations have been used in Berlin to help identify the 'type' of weather year it was for pollution (eg a 'good' or 'bad' weather year). This is useful when finding similar years to compare monitoring data before or after the LEZ implementation, or to understand whether years were particularly 'good' or 'bad' for pollution when interpreting the air quality measurements.

**Figure 13 Polar plots for NOx concentrations to identify good background indicator sites**




### 6.7. Overall air quality discussion and conclusions

As stated above, all LEZs have improved air quality and emissions so far, and many have just implemented phase 2, which is expected to have a greater impact. The LEZs with tighter emissions standards are expected to have a greater impact on air quality, but the early phases have an impact and allow the later phases to be implemented by allowing vehicle operators to adapt.

The effectiveness of an LEZ needs to be assessed in each case. In terms of the emissions standards to use, vehicle emissions testing together with emissions standards can help guide policy-makers as to which standards would be most effective for new LEZs. Affecting all vehicle types tends to be more effective, particularly for $NO_2$ if retrofitting DPFs is allowed on light duty vehicles.

The implications of the $NO_2$ cycle-beating on new LEZs depend on many factors. For example if there are many pre-Euro 3 HDVs (heavy duty vehicles) still in the fleet then the new emissions factors for Euro 5 HDVs (section 6.3) are less relevant due to the significant emissions reductions from pre-Euro 3 vehicle exclusion. If the proportion of HDVs which will retrofit with a $NO_2$-increasing DPF is high and cannot be affected and only HDVs are affected by the LEZ, then the impact of primary $NO_2$ will be less positive than elsewhere. The Netherlands gave grants towards fitting DPFs that did not increase $NO_2$ to try to influence the DPFs fitted. If the $NO_2$ concentrations in the town or city are not ozone-limited, then there is less difference whether the $NO_x$ is emitted as $NO_2$ or NO, as the NO will fairly rapidly turn into $NO_2$ anyway. However, this is less likely in cities with an air quality problem tend.

$NO_x$ retrofit is now possible, and is being done throughout Europe and the USA. It is already being used in the Norwich LEZ emissions standards. This could enable the $NO_x$ emissions to be reduced significantly towards meeting the limit values, more than outweighing the increase in primary $NO_2$. $NO_x$ retrofit will need to be implemented with care, the equipment fitted needs to fit to both the vehicle and the type of driving it usually undertakes. $NO_x$ retrofit is also more expensive than DPFs, and is often implemented together with DPFs. French LEZs will focus on $PM_{10}$, and it may well be if a second phase wishes to look at NOx retrofit, the EU-wide certification may have been completed by then. Grant funding for the more effective systems as used for Dutch DPFs may be useful.

The most impact is gained by a Euro 4 (or tighter) emissions standard LEZ for all vehicles. Euro 4 HDV-only is also likely to be positive. Measures to reduce primary $NO_2$ from retrofitting DPFs would be advantageous, particularly with an HDV-only scheme. Light duty vehicleor van LEZs where retrofitting DPFs is allowed is likely to have a more positive impact on $NO_2$ than those without. These will require partial DPFs, which, while are not ideal, should give the benefits certified in urban areas.

## 7. Costs

Similarly to the air quality section, this section pulls together costs information from the different assessments, with the details and references for the whole section being in Annex 8, which should be consulted for further information. This report includes LEZ costs that were published before February 2010.

LEZ costs can be split into four aspects:

- Costs to the authority to implement and operate
- Costs to vehicle operators to adapt to the LEZ
- Costs and benefits to society, e.g. health benefits and economic impacts
- Costs of any complementary measures.

In general, the local authorities (LAs) ran the LEZs and paid for them. There may have been alterations in the money given to the LA from the national or regional government to allow for this air quality work, but this level of detail has not been investigated. The costs here do not include the costs of setting up the national or regional frameworks. However a national framework will reduce rather than increase costs, due to issues needing to be resolved for each city and the difficulty of doing this without national support.

In terms of income from LEZ fines, in Germany[25], the income from the penalties go into the general town funds, which is also where the enforcement costs are paid from. In the Netherlands, the LEZ fines go to the National Treasury, not to the towns.

### 7.1. Costs to the authority to implement and operate

The costs to implement and operate an LEZ will depend on a number of variables. These include whether manual or automatic enforcement is chosen; all vehicles or just heavy duty vehicles are included; the size of the zone; or if it is combined with congestion charging, barrier controlled entry or other traffic management scheme. Camera enforcement is generally more expensive to set up, but can be cheaper to run. With manual enforcement, running costs depend on the frequency of control, how police are funded and how much can be built into already existing traffic enforcement. The better the enforcement, the greater the air quality impact.

Experience from the Netherlands indicates that implementation costs with manual enforcement for an average sized city (population around 200,000) is around €100,000, with annual enforcement costs around €75,000, increasing for larger cities. Set-up of camera enforcement is around €10-50,000. More detail on these costs can be found in Annex 8.

A report on expected costs in Odense (Denmark) pre-implementation gives establishment costs as around €60,000, annual enforcement as €17,000. Danish enforcement is focused primarily at the unloading points of the lorries by enforcement officers (equivalent to parking wardens), with additional stopping of vehicles being combined with regular police activities (police are required to stop moving vehicles). This may explain the lower costs – which could also be influenced by less enforcement being undertaken or the fact that these are expected rather than experienced costs. From the logic, the use of unloading points for enforcement does appear a cost-effective approach to enforcement.

Costs for LEZs that are based on different charging mechanisms, such as the Milan Ecopass or the planned Norwegian LEZs, will be different due to their different structure, and are not covered here.

### 7.2. Costs to vehicle operators

This again, has been estimated with different methodologies. This section summarises the impacts estimated, with fuller details in Annex 7, including details of the Berlin vehicle fleet. As with the air quality standards, the costs will vary with aspects such as the emissions standard, vehicles affected

25 confirmed for Mannheim

and size of LEZ. Care additionally needs to be taken in considering these costs into new situations, as DPFs are likely to have reduced in cost, as may new or second hand vehicles.

**The Netherlands**: Total Dutch cost was estimated at €15-€18m in new vehicles and DPFs, based on likely operator actions (first phase standard is Euro 4 or Euro 2 or 3 need DPF for HGVs). With 8 years depreciation period this as €1.9-€2.25m per annum.

The figures below per city are estimated and incomplete, as they assume 100% compliance (85% early 2009), no exemptions (actual 2009 7.5%) and that the operator uses the DPF grant. The figures above allow for these aspects. The average estimated total for compliance per city is €700,000. In terms of different sized Dutch LEZ cities:

- Maastricht €1.5m
- Medium-sized cities Heerlen, Breda, 's-Hertogenbosch, Eindhoven and Tilburg (~200,000 population) about €2m per city.
- Major cities of Utrecht, Rotterdam and The Hague profiles suggest €3m.
- Amsterdam is estimated as approximately €5-8m.

**Denmark**: Costs of fitting DPF in Denmark for the first phase of the LEZs in 2008 (Euro 3 or DPF for HGVs), is estimated at 299m DKK (€40m) to fit DPFs and 18m DKK (€2.5m) in annual maintenance. For the second phase in 2010 (Euro 4 or DPF), it is 317m DKK (€43m) to fit and 19.4m DKK (€2.6m) annual maintenance. This assumes all 5 LEZs had been implemented in 2008 and then tightened in 2010, however, only 3 out of the 5 cities implemented LEZs at the time of estimation. It also does not include the costs of purchasing new vehicles if this was decided upon. The unit DPF cost assumptions prior to LEZ implementation in Denmark are 44,000 DKK (€5900) retrofit cost and 2700 DKK (€363) annual maintenance costs, however, prices may have gone down with volume since.

**Germany**: A number of towns have estimated the numbers of vehicles in the fleet registered *in the town itself* that do not comply with the LEZ. This gives underestimates of the vehicles affected, as vehicles registered outside the LEZ authority must also be cleaner to access the LEZ. In all cases at the time of estimation the LEZ standard was Euro 2(PM) diesel, Euro 1 petrol for all 4-wheel vehicles. The vehicle figures are given for the following towns:

- Berlin: January 2008 there were 28,800 fewer non-compliant cars than expected registered, December 2008 32,000 fewer. December 2008 14,300 fewer pre-Euro(PM) lorries registered than expected.
- Heilbronn: 3,000 of the 58,200 cars registered in the town and 1,800 of the 5,200 lorries are not compliant.
- Bremen: As of 2005, the total registered vehicles were 33,500; pre-Euro 2 diesel and Euro 0 petrol were 1,300; Euro 2(PM) diesel 2,500; Euro 3(PM) diesel 4,400; Euro 4(PM) diesel and Euro 1 petrol 25,400.
- Mannheim: total registered vehicles 145,000, of which 12,000 pre-Euro 2(PM) diesel or Euro 0 petrol. In city centre 10% of the 30,000 vehicles.

**Turin**: 2008 (all private vehicles Euro 1, diesel light goods vehicles Euro 3 part of winter days) around 104,000 vehicles and 50,000 light goods vehicles registered in the province of Turin do not meet the standard.

### 7.3. Costs and benefits to society

The costs presented here are those available that are focused on the more general economy. It is important to balance against this is the positive health impact, which has been assessed in London and Denmark. Needless to say the costs tend to fall largely on haulage-related industries and on small operators more than larger operators – although hardship exemptions can reduce the impact (of costs, and on air quality).

In the Netherlands and Germany prior to implementation the business community over-estimated the impact that the LEZs would have, compared to that observed. Prior to implementation German businesses claimed that many businesses would go out of business, shop turnover would reduce, 1000's of job losses etc. Since implementation the business communities have confirmed that there has been no measurable impact (see Annex 8, section 21.5.2). Pre-LEZ implementation, Dutch

business estimated the costs of LEZ compliance as much higher than that which was observed in reality (see section 21.5.1).

In the Netherlands LEZ cities have not received complaints from specific groups since implementation (except street traders) that they are disproportionately affected. In addition, the number of applications under the hardship clause (which prevents businesses experiencing serious financial problems due to the LEZs) is very limited. This illustrates the difference between perception of businesses prior to LEZ implementation and the actual situation post implementation. Before the implementation of the LEZ businesses in Berlin warned of 1000's of job losses. Since the implementation no such impact is known, and the Berlin tourist board had also not noticed a negative impact. The LEZ had no noticeable impact on business of shops in Mannheim, as confirmed by the Mannheim business community.

In addition, other aspects, such as better air quality and complementary logistic measures (if implemented in towns, such as is done in the Netherlands), make a more attractive city for location, which are not possible to quantify. Impacts on noise, accessibility, safety and $CO_2$ are considered low for most LEZs. Where private cars are included, accessibility needs to be considered.

A Gothenburg haulier and supplier survey found that only 20% of respondents had a negative 'overall rating' for the LEZ, with 21% being very good, 28% fairly good, 24% neutral, 7% no response. The LEZ most hit companies that had not previously undertaken any environmental work and improved the competitiveness of those who had. There were examples of companies without the financial resources to comply, which had closed down.

Copenhagen's second phase LEZ as of 1st July 2010 is expected to give 150 fewer premature deaths, 150 fewer hospital admissions for respiratory and circulatory diseases, 750 fewer bronchitis attacks, 8,000 fewer asthma attacks and 90,000 fewer days of restricted activity due to respiratory diseases[26]. The first phase was estimated to prevent 90 deaths and save the community 80m DKK[27]. The impact on PM will be responsible for the majority of the cost savings.

### 7.4. Costs of complementary measures

This will very much depend on the complementary measures implemented and is not covered here.

## 8. LEZ complementary measures

There are two aspects to complementary measures for LEZs. Firstly, specific measures to support LEZs, such as grants for retrofits. Secondly, LEZs are not implemented in isolation, but as part of an air quality strategy, including improved public transport, traffic reduction, industrial regulation bans on smoky (domestic) fuels etc.. This keeps the balance and proportionality for different sources of pollution. It is also due to the fact that an LEZ is not a 'magic bullet' that can solve all the problems on its own, but often one of the most effective measures in the arsenal.

### 8.1. Specific measures to support LEZs

Most countries with LEZs in operation have specific LEZ support measures, the exceptions being Sweden and the UK[28]. The impact of these support measures cannot be split that of LEZs, as the changes would not happen with the 'carrot' of the support measures alone without the 'stick' of the LEZs. Many countries have incentives for early uptake of the newest Euro standard vehicles, which can also be seen as an LEZ complimentary measure.

#### 8.1.1. Denmark

There was a national grant scheme for retrofitting approved DPFs to HDVs. The grant was up to 30% of the total cost, (maximum 15,000 DKK per grant (€2,013)), and a total grant budget of 60m DKK (€8m) for 2004-9. There is also since 2010 a DKK 1,000 (€134) reduction on vehicle road tax for vehicles for all diesel vehicles with a DPF fitted.

26Presentation by the Danish Transport Ministry

27Danish National Environmental Research Institute http://naturogmiljoe.dmu.dk/Luft/2_c1/

28 The UK had grants for retrofitting that stopped once the London LEZ was announced, on the basis that incentives should not be given where there was a legal requirement to comply. This approach has not been taken in many other countries.

### 8.1.2. Germany

The only incentive aimed specifically at the LEZs is a €330 tax incentive taken off the cost of retrofitting a private car with an approved DPF, extended to 2010. In some cities, DPFs were sold out.

Other supporting financial incentives that help reduce the cost of complying with the LEZs include:

- A national scrappage scheme for cars over 9 years old (€2,500), which reduced the number of older vehicles by 1.95 million from January to August 2009. Emissions of new cars are 74%-99% less than older cars, $CO_2$ 20% less. Other countries, including the UK, Austria, France and Spain have scrappage schemes.
- The German motorway toll for heavy duty vehicles (MAUT, where HDVs are charged per km driven on German motorways) is cheaper for cleaner Euro standards and with DPFs fitted.
- Rates of road tax vary with Euro class, with newer Euro class vehicles being cheaper. There is also an additional charge for HGVs that do not Euro 5 PM levels of €1.20 per started 100cm³ capacity per year.
- The German national KFW bank offers cheap loans for buying new Euro 5 or EEV HGVs. The additional cost is set as €8,500 per vehicle; rate is 1.5% with no re-payment required for the first 2-years, an advantage of €2,550–€4,250.

### 8.1.3. Italy

The north Italian regional agreement that covers LEZs also covers many other air quality measures – almost an air quality action plan as a regional agreement that the individual regions, and then towns, can implement as appropriate in their area. This includes financial support of up to 30% for fitting DPFs, better public transport, scrappage schemes for low income households etc.. An illustrative (not extensive) list of the amounts promised to be given by the different regions is given below. The other regions will have similar schemes:

- Piemonte: €4m set aside for fitting DPFs to Euro 2 and Euro 3 buses
- Lombardia: €4m set aside for fitting DPFs to buses not exceeding 30% of the total cost, €1m for public authorities and €3m for private enterprises. €2,000 per bus over 10 metres long, €1,500 for buses under 10 metres long.
- Lombardia: €10m for €2,000 grants to replace Euro 0 (petrol or diesel) or Euro 1 (diesel) or Euro 2 (diesel) vans that operate mostly in urban distribution with a new non-diesel vehicle[29].
- Bozen had national Government funding to retrofit DPFs on all their public buses by 2009, allowing LEZ enforcement for all buses. It also gives a tender-incentive of 5% for fitting of DPFs for public building projects.
- In Bozen, a 1-year exception for road tax for all vehicles with a DPF; a 2-year exemption for vehicles with a retrofitted DPF. However, vehicles are being retrofitted due to the LEZ rather than the tax incentive.

### 8.1.4. The Netherlands

There were significant grants to meet the whole fleet for DPF retrofit, which came out of the negotiations that led to the LEZ covenant. Higher grants were given to retrofits that did not increase primary $NO_2$. All cities are operating or planning better distribution centres to help improve logistics, as well as reduce the impact of the LEZ on logistics operations (LEZs affect only lorries). These will also reduce traffic and emissions and they include:

- Measures for freight traffic
  - Traffic flow measures
  - Logistic routes to and from shopping centres
  - Lorries sharing bus lanes

29 http://www.acimi.it/bandi.htm

- Developing off-peak distribution
- Freight logistics action
- Stimulate the development of distribution centres
- Encourage other types of combined delivereies
- Reducing waste in the town
- Street management
- Other measures
- Changing Delivery rules
- Logistic key plans

#### 8.1.5. Norway

A subsidy for new vehicles is planned to accompany any LEZ implemented. This is likely to be administered nationally, but the LEZ scheme has not yet been finalised.

### 8.2. Air quality strategy actions

As discussed above, no city or town has an LEZ without it being part of an air quality action plan. We do not intend to undertake a full audit of all air quality strategies in Europe, but have given some examples below. This section is organised by the authority that the LEZs are organised on. These measures are in addition to those specific LEZ-measures above.

#### 1.1.1.1 Berlin

The second pillar of the air quality strategy in terms of traffic is an urban master plan for transport (StEP). Its aims are traffic reduction and modal shift so that only 20% of journeys in the city centre and 40% in the remaining areas are undertaken by car. The StEP is expected to reduce exhaust and the generally mileage dependent non-exhaust emissions. Other measures include the use of alternative fuels and setting of emission criteria for the municipal diesel vehicle fleet and buses.

#### 1.1.1.2 Baden-Württemberg

The action plan for the whole Land includes:

- LEZs
- HGV traffic bans in particularly high polluted streets, HGV detours, reducing through-traffic in towns, extending arterial and ring roads, building by-passes
- Speed limits, optimising vehicle flow
- Parking management and regulation
- Increasing use of public transport and extending the rail freight network
- Improving building site logistics and reducing building PM emissions

#### 8.2.1. The Netherlands

The Dutch Environment Ministry has an extensive air quality program, outlined in the tables below, as of November 2007. LEZs are a locally implemented as part of the national plan.

**Table 6. Overview of Dutch National air quality action plan**

***'Budget Day Package 2005'***

| | Effects (mln kg) | | | Costs | Costs (€/kg) | Substance |
|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | | | |
| - NOx emissions trading | 21.1 | 22.8 | 22.4 | 0 | | NOx |
| - Soot filters on new cars | pm | | | 150 mln | 50-250 | PM |
| - Retrofit filters cars | .2-.8 | 0-.5 | | 150 mln | 50-300 | PM |
| - Subsidy Euro V trucks | 4.1 | | | 90 mln | 20 | NOx |
| - Subsidy NOx converter inland shipping | .7-2.7 | | | 20 mln | 11 | NOx |
| - Sulphur-free diesel (early introduction) | | | | | | PM |
| **Total reduction:** | **1.5-10 kton NOx, 0.1-0.3 kton PM, costs € 420 mln** | | | | | |

***'Additional Package'***

| | Effects (mln kg) | | | Costs | Substance |
|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | | |
| - Road pricing (start '12) | | 1.0 | 0.8 | 5 bln | NOx+PM |
| - Low sulphur diesel for mobile mach. | 0.08 | 0.05 | 0.03 | 0 | PM |
| - Low sulphur diesel for shipping and fisheries | | 0.08 | 0.07 | 0 | PM |
| - PM reduction industry | 1.0 | 1.5 | 2 | 0 | PM |
| - Subsidy de-NOx converter hdv | 0.74 | 0.27 | 0.15 | 10 mln | NOx |
| - Air washers pig/dairy farms | 0.53 | 0.53 | 0.53 | 25 mln | $NH_3$+PM |
| **Total reduction** | **1.6 kton PM** | | | | |

#### 1.1.1.3 Dutch towns

All have air quality action plans, a few of the non-LEZ measures included in them are given here. Delft's public statement, announcing their LEZ lists natural gas buses, traffic management and active promotion of bicycles and public transport as other specific measures. Other measures in Tilburg are very clean buses since 1.1.2008, improved traffic flow/management, gas vehicles from the town and other Tilburg institutions.

### 8.3. Complementary measures conclusion

Complementary measures help with the acceptability of the LEZ. How much depends on their extent, but also on cultural aspects – the German population for example are particularly attracted to getting tax incentives. Grants towards fitting dpfs have been a particularly commonly used measure, and also well targeted.

Complementary measures can also help influence how the LEZ is complied with, for example encouraging DPF retrofits, which, especially if full filters are required, can have a more positive impact on $PM_{10}$ emissions than complying with the next Euro standard. Differential grants for filters that do not increase primary $NO_2$ have been also used to try to influence the choice of filter. Most financial incentives have been organised on a national basis, and do not fully cover the cost of the compliance of the LEZ – as required by EU law. The 30% limit of grant funding set by the EU can also include costs of maintenance of dpfs.

Non-financial incentives are less commonly used, but also very important parts of the wider air quality action plans. If LEZs affect private vehicles, local measures improving public transport would be a good way of providing complimentary measures. This will also have the potential to reduce traffic and congestion and therefore pollution in its own right. Improving logistics is another good measure.

The most significant disadvantage of complimentary measures is that they cost money, so increasing the costs of implementation.

## 9. Legal Challenges

There has been only one successful legal challenge of an LEZ. This resulted in the LEZs remaining in operation, but changing some of their requirements. Later LEZs have the option of knowing more so as to avoid the likelihood of legal challenges being successful. There have however been a number of failed legal actions against LEZs and a number of successful legal actions calling for LEZs.

### 9.1. Legal challenges against the LEZs

Below highlights a number of the legal challenges, but does not attempt to include all. Particularly in Germany the number of challenges has been high, but none have been successful.

#### 9.1.1. Sweden

Swedish LEZs have been in operation since 1996 under local legislation with each regulation separate (registration, sticker, and DPF certification). Until January 2007, retrofitting with a DPF for vehicles between 6-8 years old. This was challenged with EU Freedom of Movement law as the DPF certification was a local, separate for each city, not related to the Euro standards and therefore not equally easy for foreign vehicles compared to local vehicles, and tests were required to be made in a Swedish Laboratory. The national Government ensured compliance with the EU law by requiring retrofitting to meet the Euro standard for all pollutants. Similar approaches to retrofitting, as taken in other countries, would have been possible, but were not chosen.

#### 9.1.2. Germany

There have been many challenges to LEZs in Germany, none of which have been successful. The main challenger has been the German automobile association (ADAC), most likely because the LEZs affect private vehicles. As the LEZs are to improve air quality, the cities/Länder are legally required take action to improve air quality and LEZs are one of the most effective measures, all the legal challenges so far have failed. A few of the cases are illustrated below.

The most serious legal challenge was for Hannover and Berlin, centred on the Euro 4 stage of the LEZ. As the $PM_{10}$ limit values are met, the LEZs will be increasingly aimed at the $NO_2$ LVs. The issue was the potential of retrofitting DPFs increasing primary $NO_2$, leading the LEZ to have a negative impact on $NO_2$ concentrations (and ban Euro 1,2,3 vehicles without a DPF but with lower $NO_2$), and therefore the LEZ could be counter-productive. The court ruled, based on the information in section 20.8.1, that retrofitting DPFs on Euro 3 LDVs reduces their primary $NO_2$ emissions and that LEZs gave an overall positive impact on $NO_2$. The court found that the LEZ (and other measures) are needed to reduce $NO_2$ concentrations, and other measures without the LEZ would not have enough impact. Alternative measures with less impact on individuals are not known or not as effective. The Berlin LEZ has since confirmed leading to reductions in $NO_2$ concentrations.

In Cologne, the LEZ was challenged as having a disproportionate impact on the population. The court found the LEZ necessary, appropriate and designed to meet its purpose of improving air quality.

In Baden-Württemberg, a campervan owner challenged LEZs on the grounds that she could not travel through Schwäbisch-Gmünd on holiday. The challenge was rejected and she was not found to be eligible for an exemption.

In the Ruhr area, the LEZ was challenged by a driver who wanted to be able to drive a 27-year-old van to his family doctor. The judges ruled the LEZ was important to meet the $PM_{10}$ limit values and recommended that he should drive to the edge of the LEZ and walk the last 500m.

### 9.2. Legal challenges *for* the LEZs

The European Court ruled on 25.7.2008 that where EU LVs are exceeded, action plans are required. LEZs are also one of the measures that the EU requires to be considered when Member States apply for extensions to the EU LVs[30].

A Munich resident took a challenge to the German national court, as Bavaria had not implemented an air quality action plan and the EU $PM_{10}$ LVs were not met. This was successful, and Bavaria and Munich implemented action plans and an LEZ. Further action was taken December 2009 to extend the LEZ or a traffic ban to the Landshuter Allee (road used in both legal cases), which is outside the LEZ, with over 52 exceedences of the $PM_{10}$ limit value which has not (yet) been successful.

In May 2005 there was a challenge from a Stuttgart resident that the air quality action plan was not insufficient. The legal action was withdrawn after the EU ruling above. Stuttgart LEZ is now likely to be tightening earlier than other LEZs in Baden-Württemburg.

The Dutch high court ruled that no new planning developments were allowed that increased air quality, where the limit values were exceeded. As most of the country exceeded the limit values this in practice put a stop on all developments in the Netherlands, and resulted in the wide-ranging national air quality plan, so that any negative impact of developments was counterbalanced by improvements from the plan. Development has been since allowed and an extension for both $PM_{10}$ and $NO_2$ limit values achieved.

EU moves to take legal action on Member States that still exceed the limit values seems to be having an impact on the number of LEZs, which have been increasing since action started, as well as the number of countries investigating LEZs.

### 9.3. Avoiding legal challenges

A well set-up and considered LEZ that is part of an overall air quality action plan, which aims and can reasonably be expected to lead to air quality improvements should not be at risk from a successful challenge. All EU legal aspects should be complied, for freedom of movement, proportionality, non-discriminatory. Including private vehicles may make it more likely that a legal challenge will be attempted, but not necessarily be successful, and good communication may help to minimise the number of legal challenges.

## 10. Concluding recommendations for Frances LEZs

This section pulls together the conclusions and recommendations for the French LEZs. It is based on the rest of the report, particularly sections 2, 3 and 4, and should be read together with these sections, as many issues are not repeated here.

In order to assist in meeting the EU limit values and gaining an extension to the deadlines, Low Emission zones need to be implemented as part of an integrated air quality ‘action plan’, of which they are often the most significant part. The air quality action plan also needs to include measures for non-transport sources and non-LEZ transport measures (such as traffic management and reduction, tax incentives for cleaner vehicles). This needs to be made particularly clear in view of the French name ZAPA (Zone d'Action Prioritaire pour l'Air), which could be interpreted as an air quality action plan.

A national framework is recommended, making implementation smoother, cheaper and less legally risky. This framework should be notified to the EU Commission, and ensure that all EU legal issues are met. This way the national authorities can ensure that the requirement for all LEZs to comply with EU can be met. The national framework should include issues like:

- which emissions standards can be set,
- which vehicles can be affected,
- the identification of vehicle Euro standard, both in the national vehicle database and also with stickers if used,

30 ANNEX XV, DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

- how foreign vehicles are treated,
- road signs,
- national website,
- national exemptions, including defining key roads
- certification for diesel particulate filters
- legal issues, which laws, laws allowing LEZ…
- enforcement method(s) and penalties for non-compliance.

It can also be advantageous if the national framework also outlines:

- the assessment required before LEZ implementation decision and for monitoring of the LEZ
- process to implement an LEZ
- discussions with key stakeholders
- EU wide dissemination of LEZ information
- Scope of local exemptions
- Complimentary measures

A balance should be taken between simplicity other aspects. If all vehicles are to be included, then petrol and diesel standards make sense in terms of their emissions and equality issues. Emissions standards should be based on the Euro standards. Phasing emissions standards is to be recommended, with progressively strict emissions standards, including a Euro VI standard for heavy duty diesel vehicles to help support future $NO_2$ limit value compliance. The phasing of PM and then NOx retrofit would also make sense, in the light of the longer time it will take to produce a NOx retrofit certification, whereas DPF retrofit certification is currently available. There may be acceptability (and speed) advantages introducing lighter duty vehicles in a later phase, justified by the lower emissions impact per vehicle.

Allowing PM abatement (in practice diesel particulate filters, DPFs) to meet the set Euro standard is recommended (so eg a standard of Euro IV(PM), and can allow a stricter emissions standards with less impact on vehicle operators. Adopting an existing DPF certification is particularly recommended, taking that from London (for heavy and medium duty) and Italy (for cars), potentially changing them to allow no increase in primary $NO_2$, instead of the 30% increase (London) or the 30% of NOx (Italy) that the current schemes allow. However it first needs to be checked whether this can be done legally, with respect of EU law and the freedom of movement principle. A NOx retrofit requirement for heavy duty vehicles could be added in a later phase of the LEZ.

It needs to be determined that implementing an LEZ will have a positive impact on air quality before deciding to implement, and also in deciding to strengthen the LEZ. In achieving this there is likely to be a balance between emissions standards, vehicles affected and LEZ area. Assessments need to be done before and after implementation.

There needs to be sufficient enforcement that the LEZs are respected. If manual enforcement is used, there should be national stickers. Manual enforcement should have higher penalties due to the reduced chance of being caught. ‘Points on the licence’ can be an effective penalty, if the LEZ is enforced with criminal law. Using with civil law may enable camera enforcement with its higher capture rate.

Exemptions should be kept to a minimum, to ensure that the air quality benefits are not ‘exemptioned’ away, and also that the LEZ is seen as an effective measure. However, it is inevitable that some exemptions are required, including those for key roads required by EU law. Hardship exemptions can be an effective way to reduce negative socio-economic impacts, which should be minimised from any LEZ. Complimentary measures, for example financial assistance (grants or cheap loans) for the fitting of DPFs and buying newer vehicles as well as improving logistics and public transport can also be useful measures to both reduce the socio-economic impact and increase acceptance. Motorways and key TEN-roads need to be exempt, except where they lead only to the LEZ.

Communication with the public and stakeholders is important, to increase acceptability and compliance, but also to comply with EU law. Involving stakeholders at an early stage can be advantageous, ideally through negotiation (as in the Netherlands), or through information spreading and consultations. High public understanding of the dangers to health of air quality also help those affected to accept it – particularly when it is pointed out that those driving are most affected by high pollution concentrations.

A national framework for LEZs helps in many ways, including increasing acceptability. Fiscal complimentary measures have been usually organised on a national level. Retrofit certification needs to be nationally organised, as do any windscreen stickers used. It helps spreading information – an important EU legal aspect – if there is coordination of LEZs and a single information dissemination source per country, in addition to the EU-wide dissemination through the LEEZEN Network.

## 11. Disclaimer

The information given in this report is based on the best knowledge and understanding of the current situation by Sadler Consultants, and is accepted as such. Reasonable efforts have been taken to ensure that this report gives a complete and current picture of the issues covered in this report. However, the situation can change rapidly, and plans, details and assessments may not always be shared with external bodies.

This report is based upon a collection of available published work. The report tries to put it in context and assist in the interpretation of it. However, we are not responsible for the quality or accuracy of this information, or conclusions drawn from them.

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**With thanks to**

To all cities that have published LEZ monitoring information in the public domain

Members of LEEZEN and the EU Commission who support the work of the LEEZEN Network. Through our work, and particularly that of the LEEZEN project, Sadler Consultants is an expert source of knowledge on LEZs around Europe.

Berlin city authority and the Environmental Research Group of Kings College London who provided detailed air quality assessment information.

## 12. Annexes

## 13. Annex 1. Overview of LEZs across Europe

Below is a table giving all the LEZs in operation, with the vehicles and emissions standards affected, their start date and their end date.

### Table 7. Overview of LEZs across Europe

Key:

A bold date means that the LEZ is currently in operation, plain text those that are in concrete planning.

Where there is an end date given for the LEZ standards it is almost always followed by stricter standards starting from the given end date, shown in a separate line further down this list for the same city.

An emissions standard of e.g. Euro 3(PM) means that the particulate emissions standard must be met for that Euro standard vehicle. This can be done by fitting a diesel particulate filter to a vehicle of an earlier Euro standard or with a vehicle meeting the full Euro standard. (NOx) means NOx abatement equipment can be used to meet the standards set.

Where an LEZ is planned or very likely, but has not set a firm start date, an approximate date is given in this table, marked with Est.

Not all towns in Lombardia and many in Emilia Romagna (Italy) with LEZs are listed separately in these tables. In Lombardia there are around 1600 individual communes included, which can be found on the LEEZEN website. In Emilia Romagna there are 95 further communes with LEZs, a list of which can be found on the LEEZEN website.

| Country/ | City/Area | Est? | Standard-start date | end date | Vehicles | petrol; m/c =motorcycles | diesel | Retrofit? |
|---|---|---|---|---|---|---|---|---|
| Austria | A12 motorway (Tirol) | | **01/01/07** | - - - | Lorries at night | | Euro 4 | N |
| Austria | A12 motorway (Tirol) | | **01/11/08** | - - - | Trailer & tractor-trailer lorries > 7.5T | | Euro 3 | N |
| Austria | A12 motorway (Tirol) | | **01/11/09** | - - - | Lorries without trailers and tractor-trailers > 7.5T | | Euro 2 | N |
| Czech Republic | Praha (Prague) | | **01/01/08** | - - - | Vehicles over 3.5T | -- | Euro 2 | |
| Denmark | Aalborg | | **01/07/10** | - - - | Vehicles over 3.5T | | Euro 4 or filter | Y |
| Denmark | Århus | | **01/09/10** | - - - | Vehicles over 3.5T | | Euro 4 or filter | Y |
| Denmark | Frederiksberg | | **01/07/10** | - - - | Vehicles over 3.5T | | Euro 4 or filter | Y |
| Denmark | København (Copenhagen) | | **01/07/10** | - - - | Vehicles over 3.5T | | Euro 4 or filter | Y |
| Denmark | Odense | | **01/07/10** | - - - | Vehicles over 3.5T | | Euro 4 or filter | Y |
| Germany | Augsburg | | **01/01/11** | 01/10/12 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Augsburg | Est. | 01/10/12 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Berlin | | **01/01/10** | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany (Ruhr) | Bochum | | **01/10/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Bonn | | **01/01/10** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany (Ruhr) | Bottrop | | **01/10/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Bremen | | **01/01/10** | 01/07/11 | All vehicles except | Euro 1 | Euro 3(PM) | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | motorcycles | | | |
| Germany | Bremen | 01/07/11 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany (Ruhr) | Dortmund | **12/01/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) or 3(PM) | Y |
| Germany (Ruhr) | Duisburg | **01/10/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany (NRW) | Düsseldorf | **01/03/11** | - - - | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany (Ruhr) | Essen | **01/10/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Frankfurt | **01/01/10** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Frankfurt | 01/01/12 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Freiburg | **01/01/10** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Freiburg | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Freiburg | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany (Ruhr) | Gelsenkirchen | **01/10/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Hannover | **01/01/10** | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Heidelberg | **01/01/10** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Heidelberg | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Heidelberg | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Heilbronn | **01/01/09** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Heilbronn | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3 (PM) | Y |
| Germany | Heilbronn | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4 (PM) | Y |
| Germany | Herrenberg | **01/01/09** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Herrenberg | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Herrenberg | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4 (PM) | Y |
| Germany | Ilsfeld | **01/03/08** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Ilsfeld | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Ilsfeld | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4 (PM) | Y |
| Germany | Karlsruhe | **01/01/09** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Karlsruhe | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Karlsruhe | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Köln (Cologne) | **01/01/08** | - - - | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany (NRW) | Krefeld | **01/01/11** | - - - | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Leipzig | **01/03/11** | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Leonberg | **01/03/08** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Leonberg | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Leonberg | 01/01/13 | - - - | All vehicles except | Euro 1 | Euro 4(PM) | Y |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | motorcycles | | | |
| | | | | All vehicles except | | | |
| Germany | Ludwigsburg | **01/03/08** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Ludwigsburg | 01/01/12 | 01/01/13 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Ludwigsburg | 01/01/13 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Mannheim | **01/03/08** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Mannheim | 01/01/12 | 01/01/13 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Mannheim | 01/01/13 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Markgröningen | 01/07/11 | 01/01/13 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Markgröningen | 01/01/13 | - - - | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Mühlacker | **01/01/09** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Mühlacker | 01/01/12 | 01/01/13 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Mühlacker | 01/01/13 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | | | | All vehicles except | | | |
| (Ruhr) | Mühlheim | **01/10/08** | - - - | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | München (Munich) | **01/10/10** | 01/10/12 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | München (Munich) | 01/10/12 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Münster | **01/01/10** | - - - | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Neu-Ulm | **01/11/09** | - - - | motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | | | | All vehicles except | | | |
| (NRW) | Neuss | **15/02/10** | - - - | motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | | | | All vehicles except | | | |
| (Ruhr) | Oberhausen | **01/10/08** | - - - | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Osnabrück | **03/01/11** | 02/01/12 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Osnabrück | 03/01/12 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pfinztal | **01/01/10** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pfinztal | 01/01/12 | 01/01/13 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pfinztal | 01/01/13 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pforzheim | **01/01/09** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pforzheim | 01/01/12 | 01/01/13 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pforzheim | 01/01/13 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pleidelsheim | **01/07/08** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pleidelsheim | 01/01/12 | 01/01/13 | motorcycles | Euro 1 | Euro 3(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Pleidelsheim | 01/12/13 | - - - | motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | | | | All vehicles except | | | |
| (Ruhr) | Recklinghausen | **01/10/08** | - - - | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Regensburg | Est. 01/07/11 | - - - | motorcycles | Euro 1 | Euro 2(PM) | Y |
| | | | | All vehicles except | | | |
| Germany | Reutlingen | **01/03/08** | 01/01/12 | motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Reutlingen | 01/01/12 | 01/01/13 | All vehicles except | Euro 1 | Euro 3(PM) | Y |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | motorcycles | | | |
| Germany | Reutlingen | | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Schwäbisch-Gmünd | | **01/03/08** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Schwäbisch-Gmünd | | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Schwäbisch-Gmünd | | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Stuttgart | | **01/07/10** | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Stuttgart | | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Tübingen | | **01/03/08** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Tübingen | | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Tübingen | | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany | Ulm | | **01/01/09** | 01/01/12 | All vehicles except motorcycles | Euro 1 | Euro 2(PM) | Y |
| Germany | Ulm | | 01/01/12 | 01/01/13 | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Germany | Ulm | | 01/01/13 | - - - | All vehicles except motorcycles | Euro 1 | Euro 4(PM) | Y |
| Germany (NRW) | Wuppertal | | **01/03/11** | - - - | All vehicles except motorcycles | Euro 1 | Euro 3(PM) | Y |
| Italy (piem) | Acqui Terme | | **01/11/07** | - - - | All vehicles <3.5T | Pedestrian zone \| m/c Euro 1 & <10yrs | Pedestrian zone | Y |
| Italy (Trent) | Ala | Est. | 01/11/11 | 31/03/12 | All vehicles | Euro 1 \| m/c Euro 1, no 2-stroke | Euro 2 | Y |
| Italy (piem) | Alba | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Alessandria | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (Aosta) | Aosta | Est. | 08/11/11 | 31/03/12 | All vehicles | Euro 1 | Euro 1 | |
| Italy (piem) | Asti | | **01/11/07** | - - - | All vehicles <3.5T | Pedestrian zone \| m/c Euro 1 and <10yrs | Pedestrian zone | Y |
| Italy (piem) | Beinasco | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (lomb) | Bergamo | | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (piem) | Biella | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (Em-Ro) | Bologna | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Bologna | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (bolz) | Bolzano (Bozen) | | 01/11/11 | 31/03/12 | All vehicles | Euro 2 \| m/c no 2-stroke | Euro 2(PM) | Y |
| Italy (bolz) | Bolzano (Bozen) | | 01/11/12 | 31/03/13 | All vehicles | Euro 2 \| m/c no 2-stroke | Euro 2(PM) | Y |
| Italy (bolz) | Bolzano (Bozen) | | 01/11/13 | 31/03/14 | All vehicles | Euro 2 \| m/c no 2-stroke | Euro 3(PM) | Y |
| Italy (piem) | Borgaro Torinese | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Borgomanero | | **01/11/07** | - - - | All vehicles <3.5T | Euro 3 \| m/c Euro 1 and <10yrs | Euro 3 | Y |
| Italy (piem) | Bra | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Italy (lomb) | Brescia | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (bolz) | Bressanone (Brixen) | 01/11/11 | 31/03/12 | All vehicles | Euro 2 \| m/c no 2-stroke | Euro 2(PM) | Y |
| Italy (bolz) | Bressanone (Brixen) | 01/11/12 | 31/03/13 | All vehicles | Euro 2 \| m/c no 2-stroke | Euro 2(PM) | Y |
| Italy (bolz) | Bressanone (Brixen) | 01/11/13 | 31/03/14 | All vehicles | Euro 2 | Euro 3(PM) | Y |
| Italy (TOSC) | Calenzano | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (TOSC) | Campi Bisenzio | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (TOSC) | Capannori | **01/04/06** | 31/12/11 | All vehicles | Euro 1, 2-stroke m/c Euro 2 | Cars Euro 2, others Euro 1 | Y |
| Italy (piem) | Carmagnola | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 m/c Euro 1 & <10yrs | Euro 2 | Y |
| Italy (Em-Ro) | Carpi | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Carpi | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (lomb) | Carpignano | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (Tosc) | Carrara | **01/09/10** | - - - | All vehicles | Euro 1; m/c Euro 1 & 2 | Euro 1 or 2 | Y |
| Italy (piem) | Casale Monferrato | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 & <10yrs | Euro 2 | Y |
| Italy (Em-Ro) | Castel Bolognese | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Castel Bolognese | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (Em-Ro) | Castenaso | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 2 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Castenaso | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (Em-Ro) | Cesena | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Cesena | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (piem) | Chieri | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Chivasso | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Collegno | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (lomb) | Como | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (TOSC) | Comune di Signa | **01/04/06** | 31/12/11 | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (lomb) | Cremona | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (piem) | Cuneo | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 & <10yrs | Euro 2 | Y |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Italy (lomb) | Dovera | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (TOSC) | Empoli | **01/04/06** | - - - | All vehicles | Euro 1, m/c Euro 1 or 2 | Euro 1 or 2 or filter | Yes |
| Italy (Em-Ro) | Faenza | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Faenza | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (Em-Ro) | Ferrara | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Ferrara | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (TOSC) | Firenze | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/cycles | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (Em-Ro) | Forlì | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Forlì | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (Em-Ro) | Fornovo di Taro | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Fornovo di Taro | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (piem) | Fossano | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (TOSC) | Ginestra Fiorentina | **01/01/06** | - - - | | m/c: No 2 stroke motorcycles & mopeds | cars Euro 4, HGV Euro 2 | |
| Italy (piem) | Grugliasco | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (Em-Ro) | Imola | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Imola | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (piem) | Ivrea | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (TOSC) | Lastra a Signa | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (lomb) | Lecco | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (Trent) | Levico Terme Est. | 10/01/12 | 31/03/12 | All vehicles | Euro 1 \| m/c no 2-stroke | Euro 2 | Y |
| Italy (TOSC) | Livorno | **01/04/06** | - - - | All vehicles | Euro 1, m/c Euro 1 or 2 | Euro 1 or 2 or filter | Yes |
| Italy (lomb) | Lodi | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (lomb) | Lombardia outside the Cities | 15/10/11 | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (TOSC) | Lucca | **01/04/06** | - - - | All vehicles | Euro 1, m/c Euro 1 or 2 | Euro 1 or 2 or filter | Yes |
| Italy (lomb) | Mantova | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Italy (trent) | Mezzocorona | Est. | 01/12/11 | 31/03/12 | All vehicles | Euro 1 \| m/c Euro 1 | Euro 2 | Y |
| Italy (lomb) | Milan Ecopass | | **01/01/08** | - - - | All vehicles | Euro 3 | Euro 4(PM) | Y |
| Italy (lomb) | Milano | | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (Em-Ro) | Modena | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Modena | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (piem) | Moncalieri | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Mondovi' | | **01/11/07** | - - - | All vehicles <3.5T | Pedestrian zone \| m/c Euro 1 & <10yrs | Pedestrian zone | Y |
| Italy | Mont Blanc tunnel | | **09/03/02** | - - - | Vehicles over 3.5T | | Euro 1 & 2 | No |
| Italy (Em-Ro) | Monte San Pietro | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Monte San Pietro | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (-) | Napoli | | **01/10/10** | 31/12/11 | All vehicles | Euro 4 \| m/c no 2-stroke | Euro 4 | No |
| Italy (piem) | Nichelino | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Novara | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Novi Ligure | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Orbassano | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy | Palermo | | **06/11/08** | - - - | All vehicles | Euro 1 or 3 | Euro 1 or 3 | N |
| Italy (Em-Ro) | Parma | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Parma | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (lomb) | Pavia | | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (Umbria) | Perugia | Est. | 10/12/11 | 31/03/12 | All vehicles | Euro 1 \| m/c Euro 1 | Euro 1 | Y |
| Italy (Em-Ro) | Piacenza | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Piacenza | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (piem) | Pinerolo | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (TOSC) | Pisa | | **01/04/06** | - - - | All vehicles | Euro 1 \| m/c Euro 1 | Euro 1 | Yes |
| Italy (TOSC) | Ponte A Signa | | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (Umbria) | Ponte San Giovanni | Est. | 10/12/11 | 31/03/12 | All vehicles | Euro 1 \| m/c Euro 1 | Euro 1 | Y |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Italy (TOSC) | Porto Di Mezzo | | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (TOSC) | Prato | | **01/04/06** | - - - | All vehicles | Euro 1, m/c Euro 1 or 2 | Euro 1 or 2 or filter | Yes |
| Italy (Em-Ro) | Ravenna | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Ravenna | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (Em-Ro) | Reggio Emilia | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Reggio Emilia | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (Em-Ro) | Rimini | | 01/11/11 | 07/01/12 | All vehicles | Euro 1; m/c 2-stroke Euro 1 | Euro 3(PM) | Y |
| Italy (Em-Ro) | Rimini | | 07/01/12 | 31/03/12 | All vehicles | Euro 2 or 4; m/c 2-stroke Euro 2 | Euro 3(PM) or 4(PM) | Y |
| Italy (piem) | Rivoli | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy | Rome | | **01/01/07** | - - - | Motorcycles | \| m/c Euro 1 | | N |
| Italy (Trent) | Rovereto | Est. | 14/02/12 | 31/03/12 | All vehicles | Euro 1 \| m/c Euro 1 | Euro 2 | Y |
| Italy | Rovigo | | 02/11/10 | 19/12/10 | All vehicles | Euro 1; m/c Euro 1 | Euro 1 | n |
| Italy | Rovigo | | 10/01/11 | 31/03/11 | All vehicles | Euro 1; m/c Euro 1 | Euro 1 | n |
| Italy (piem) | San Mauro Torinese | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Savigliano | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (TOSC) | Scandicci | | **01/04/06** | 31/12/11 | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (TOSC) | Sesto Fiorentino | | **01/04/06** | - - - | All vehicles | Euro 2, no 2-stroke m/c | Cars Euro 4, Goods vehicles Euro 2 | Yes |
| Italy (piem) | Settimo Torinese | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Torino | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (piem) | Tortona | | **01/11/07** | - - - | All vehicles <3.5T | Euro 3 \| m/c Euro 3 | Euro 3 or PDF | Y |
| Italy (Trent) | Trento | Est. | 10/01/12 | 31/03/12 | All vehicles | Euro 1 \| m/c Euro 2 | Euro 2 | Y |
| Italy (piem) | Valenza | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (lomb) | Valle Salimbene | | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (lomb) | Varese | | **15/10/10** | - - - | All vehicles | Euro 1 \| m/c 2-stroke Euro 1 | Euro 2(PM) | Y |
| Italy (piem) | Venaria Reale | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Italy (piem) | Vercelli | | **01/11/07** | - - - | All vehicles <3.5T | Euro 1 \| m/c Euro 1 and <10yrs | Euro 2 | Y |
| Italy (Ve) | Verona | | 02/12/09 | 01/12/10 | Commercial vehicles | Euro 2; m/c Euro 2 | | Y |
| Italy (Ve) | Verona | | **01/12/10** | 31/12/14 | Commercial vehicles | Euro 3; m/c Euro 3 | Euro 3 | N |
| Italy (TOSC) | Viareggio | | **01/04/06** | - - - | All vehicles | Euro 1, m/c Euro 1 or 2 or no 2-stroke | Euro 1 or 2 or filter | Yes |
| Netherlands | Amsterdam | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Amsterdam | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Arnhem | Est | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Breda | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Breda | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Delft | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Delft | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Den Haag (The Hague) | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Den Haag (The Hague) | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Eindhoven | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Eindhoven | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Leiden | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Leiden | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Maastricht | | **01/03/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Maastricht | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Rijswijk | | 01/11/11 | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Rijswijk | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Rotterdam | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Rotterdam | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | s'-Hertogenbosch | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | s'-Hertogenbosch | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Schiedam | Est. | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Tilburg | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Tilburg | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |
| Netherlands | Utrecht | | **01/01/10** | 01/07/13 | Lorries over 3.5T | | Euro 3 + filter | Y |
| Netherlands | Utrecht | | 01/07/13 | - - - | Lorries over 3.5T | | Euro 4 | N |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Norway | Bergen | Est. | 01/01/12 | - - - | Vehicles over 3.5T | significant charge for pre-Euro 4 | N |
| Norway | Oslo | Est. | 01/01/12 | - - - | Vehicles over 3.5T | significant charge for pre-Euro 4 | N |
| Norway | Trondheim | Est. | 01/01/12 | - - - | Vehicles over 3.5T | significant charge for pre-Euro 4 | N |
| Sweden | Göteborg (Gothenberg) | | **01/01/10** | - - - | Vehicles over 3.5T | <6 years, 6-8 must be at least Euro 3 | N |
| Sweden | Helsingborg | | **01/01/10** | - - - | Vehicles over 3.5T | <6 years, 6-8 must be at least Euro 3 | N |
| Sweden | Lund | | **01/01/10** | - - - | Vehicles over 3.5T | <6 years, 6-8 must be at least Euro 3 | N |
| Sweden | Malmö | | **01/01/10** | - - - | Vehicles over 3.5T | <6 years, 6-8 must be at least Euro 3 | N |
| Sweden | Mölndal | | **01/07/10** | - - - | Vehicles over 3.5T | <6 years, 6-8 must be at least Euro 3 | N |
| Sweden | Stockholm | | **01/01/10** | - - - | Vehicles over 3.5T | <6 years, 6-8 must be at least Euro 3 | N |
| UK | London | | **07/07/08** | 02/01/12 | Lorries >3.5t, Buses & Coaches >5t | Euro 3 (PM) | Y |
| UK | London | | 01/01/12 | - - - | Vehicles 1.205t-3.5T, Minibuses<5t | Euro 3 (PM) | Y |
| UK | London | | 03/01/12 | - - - | Lorries >3.5t, Buses & Coaches >5t | Euro 4(PM) | Y |
| UK | Norwich | | **01/06/08** | - - - | Local bus | Euro 3(NOx) | Y |
| UK | Oxford | | 01/01/14 | - - - | Local bus | Euro V | Y |

An updated version of this table can be found on www.lowemissionzones.eu/emission-standards-table, as can versions sorted by vehicle type and start date.

## 14. Annex 2. Further details on EU legal issues[31]

### 14.1.1. Freedom of movement

It is very important that EU law is complied with when setting up an LEZ, to minimise risks of legal challenge to the LEZ (as in Sweden, see section 1.2.7). In some cases LEZ authorities consulted with the Commission to ensure that EU legal issues were resolved in implementing their LEZ.

The main law is the freedom of movement issue, i.e. that LEZs may constitute a barrier to the free flow of goods and therefore conflict with Article 28 of the EC Treaty. Within the internal market, such restrictions are prohibited unless they are justified under Article 30 of the EC Treaty or, in the case of rules applying without distinction to all products, their application is necessary to meet an overriding requirement of general public importance (cf. European Court of Justice Case 120/78 Cassis de Dijon).

To be justified under Article 30 of the Treaty, LEZs must be based on certain grounds, such as “the protection of health and life of humans, animals or plants”, or “the protection of national treasures possessing artistic, historical or archaeological value” (such as historic buildings), and in any event, they can not constitute a means of arbitrary discrimination or a disguised restriction to trade.

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Articles 28 and 30 of the Treaty have been a permanent source of case law. Although none of the cases have concerned environmental zones as such, the European Court of Justice has made it clear that, to be compatible with the Treaty, any restrictions affecting intra-Community trade have to be necessary, proportionate and non-discriminatory (see below).

The EU Green Paper on Urban Transport also said that:

“Restrictions should pay attention to interferences with through-traffic roads, as the impact on the transport infrastructure may be large and enforcement uneasy.

The perimeter of the zone should also be clear for road users. In existing cases, the most common boundaries for the zone are natural and physical barriers, ring roads, and administrative borders.

Clear signs and information boards with maps of alternative routes are necessary if the system prohibits access for certain groups of vehicles in a larger area. Information campaigns with posters, brochures, websites and the media will be needed to explain the meaning and goals as well as enforcement procedures.”

### 14.1.2. Proportionality

Any measures that could restrict community trade (such as traffic restrictions such as LEZs) are required by EU law to be necessary and proportional (no more restrictive to trade than is required) to reduce the high level of ambient air quality.

A good example is represented by LEZs addressing the most polluting (Euro) categories of vehicles, which are clearly to be preferred to general or “blind” bans: assuming that 80% of traffic emissions in a given area is generated by 10% of vehicles, targeting the most polluting segment of the fleet is more likely to meet the proportionality criteria.

As regards the necessity test, the air quality framework directive provides that “Member States shall take the necessary measures to ensure compliance with the limit values”. Measures “to control and, where necessary, suspend activities, including motor-vehicle traffic” are explicitly referred to in Article 7(3) as possible elements in the action plans that member States must draw up, indicating the measures to be taken in the short term where there is a risk of the limit values and/or alert thresholds being exceeded. While not explicitly referred to elsewhere, it is implicit that such measures could as well, depending on the specific circumstances, be deemed necessary for long-term compliance with the limit values, i.e. outside the context of specific short-term pollution episodes. In any event, given that binding limit values have been laid down by EC legislation for the protection of human health and the environment, the measures needed to ensure compliance with such limit values would, as a general rule, meet the necessity test.

### 14.1.3. Non-discriminatory

Any measures that could restrict community trade (such as traffic restrictions such as LEZs) are required by EU law to be non-discriminatory. They may not discriminate, neither directly nor indirectly, on grounds of such as nationality or place of establishment.

As an example, a restriction accepting only vehicles equipped with a given emission reduction technology which can only be approved in a given Member State may, indirectly, be discriminatory. There are two options for this.

1. to exempt “foreign” vehicles from LEZs - although this can lead to problems with the home fleet
2. use entry standards based on Euro standards.

All LEZs so far have taken the second option. Some have taken age as (a proxy for Euro standard), however Euro standard itself is clearer where possible. It is worth noting that the EC Treaty forbids discrimination against foreign goods, but not against a country’s own goods (also known as "discrimination à rebours" in the case law of the European Court of Justice).

### 14.1.4. Notification

Generally when national Governments undertake measures that have the potential to affect the freedom of moment, or give financial incentives, these measures should be notified to the Commission. There are exceptions, e.g. for financial incentives when they are under a certain limit.

Local schemes do not need to be notified and the Commission does not want that every LEZ notified. The German Länder have some responsibility to Europe, so asked the Commission whether they had to notify, and were told not.

Some LEZs (e.g. Berlin) have decided to notify anyway to be on the safe side, as they could fit the process into their timescales. Others (e.g. London) decided for a dialogue with the Commission and to ensure that all the EU legal aspects are met.

One aspect that notification does is spread the information around Europe (or those that look at the EU notification lists). If notification is not undertaken, then it is even more important to spread the information around Europe is particularly important to show that the scheme is not being discriminating to foreign vehicles (who would not reasonably know about the scheme).

A number of Länder in Germany notified the Commission of their LEZs, because they felt it was not clear if this was required, and they also had the time and wanted to be on the safe side. As LEZs have potential issues with EU law, national frameworks need to be Notified to the Commission. It is the responsibility of the national Government to ensure that any 'free-standing' LEZs without frameworks are in line with EU law. The Länder have responsibilities directly to the EU for meeting the air quality LVs, so their position was not clear. It is not the wish of the Commission that every LEZ city is notified. Where there is no national framework, cities such as London have taken the precaution of contacting the Commission and ensuring that their schemes are in line with EU law, but not notified. National schemes should be notified.

## 15. Annex 3 London DPF certification scheme

See separate pdf file.

## 16. Annex 4. Summaries of the German and Italian DPF certification schemes

*Table 8. Overview of the requirements for the German DPF certification.*

| To prove | Durability | Require: | Other Emissions | Back Pressure | Additive | Monitoring | Other |
|---|---|---|---|---|---|---|---|
| Engine bench certification according to 88/77/EC. ESC & ETC cycles. Maybe also modified ESC (tbc). Engine family Approach like the US - 100-6% of base engine within the scope of application (engine family with respect to annex I item 8.2 of directive 88/77) & smallest used filter volume within the scope of application. Emissions tests every 5th ETC cycle to test regeneration. | Efficiency guaranteed when operating according to its intended to 200000 km. Engines with swept volume <0.75 $dm^3$/cylinder & speed >3000 $min^{-1}$ require 80 000 km. Endurance test of >25 ETC cycles – also to test regeneration. Free maintenance included in sale contract as often as required up to 80000 /200000 km | gravimetric PM reduction. Class A 90% reduction. Class B 50%. Systems for engines with a swept volume <0.75 $dm^3$/ cylinder & speed of >3000 $min^{-1}$ a minimum of 30% is applicable. For Class 4 HDV PM emissions reduction needs to be 65% | As per originally approved Euro class. $NO_2$/NOx ration recorded in initial and retrofitted state. Opacity according to 88/77 <0.8$m^{-1}$. Maximum 4% fuel penalty | Regeneration. test under boundary loaded conditions - boundary loading or after maximum 100 hours a thermal regeneration is initiated – <15% deviation from pre-loading test data for gases & <20% for PM. Must state that exhaust gas temps in regeneration. are non-critical | No additive allowed in Class B. If additive used, issue statement of no objection of the combination of additive & system from Government Agency | ***Temporarily disabling of the system if not meet requirements. Prove a) conditions disabling activated / deactivated b) disabling only to protect engine or DPF & not permanent. c) lasts max 2 test cycles d) durability criteria still met e) driver informed. Existing OBD /engine management not impaired.*** | Installation manual requirements speci Each system sold h installation manual copy type approval Model law approval |

The emissions requirements for the different emissions classes are given below:

**For light duty vehicles:**

- **PM 0 and PM 01** are designed for retrofitting of Euro-1 diesel cars. By retrofitting with a particulate filter the particulate emissions standard for Euro-2 diesel cars of 0,1 g/km must be reached. Heavy vehicles can also meet the particulate Euro 3 emissions standard.

- **PM 1** is designed for retrofitting of Euro-1 and Euro-2 diesel cars. By retrofitting a particulate filter the particulate emissions standard for Euro-3 diesel cars of 0,05 g/km

must be reached.

- **PM 2** is designed for retrofitting of Euro-3 diesel cars. By retrofitting of a particulate filter the particulate Euro-4 car emissions standards of 0,025 g/km must be reached.

- **PM 3** is designed for retrofitting of Euro-4 diesel cars that are not fitted with a filter at the factory. They must meet the Euro 4 particle standard of only 0,025 g/km. With the retrofitting of a filter the particulate emission of 0,0125 g/km must be reached.

- **PM 4** is designed for the future Euro 5 with a foreseen particle emissions of 0,005 g/km. This level would be for retrofitting of on-road Euro 4 diesel cars that are appropriately prepared at the factory.

- **PM 5** is valid for Euro-3 and Euro-4 diesel cars, that are prepared at the factory that meet the future Euro 5 prescribed particulate emissions standard of 0,005 g/km. These vehicles achieve Class 4.

**For lorries and buses:**

- **PMK 01 and PMK 0** are designed for retrofitting of Euro 1 diesel HGV. By retrofitting a filter the particle emissions standard for Euro 2 diesel HGV must be reached. A few vehicles with PMK 01 also reach the particle emissions standard for Euro 3

- **PMK 1** is designed for the retrofitting of Euro 1 and Euro 2 diesel heavy goods vehicles (HGVs). By retrofitting a particulate filter the particulate emissions standard for Euro 3 diesel HGV must be reached.

- **PMK 2** is designed for retrofitting of Euro 1, Euro 2 and Euro 3 diesel HGV. By retrofitting a particulate filter the emissions must meet the particulate emissions standard for Euro 4 diesel HGV.

- **PMK 3 and PMK 4** are designed for retrofitting of lighter lorries. The emissions criteria are the particle emissions class PM 3 or PM4 for cars.

Table 9 below gives the different emissions classes and PM standards. The numbers in the tables that represent vehicle chassis numbers.

*Table 9. Emissions classes and PM standards of the German LEZ framework*

| | Petrol /Spark ignition (Petrol, Gas, Ethanol) | | Diesel (Diesel, Biodiesel) | | | |
|---|---|---|---|---|---|---|
| **Emissions Group** | **Cars** | **HGV/Bus/ goods vehicles** | **Car** With retrofit | **Car** No retrofit | **HGV/Bus/ goods vehicles** without retrofit | **HGV/Bus/goods vehicles** with retrofit |
| Class 2  | | | **Level PM 01:** 19, 20, 23, 24 **Level PM 0:** 14, 16, 18, 21, 22, 34, 40, 77 | 25 - 29, 35, 41 - 43, 53, 60, 61 | 20, 21, 22, 33, 43, 53, 60, 61 | Level PMK 01: 40 - 42, 50 - 52 **Level PMK 0:** 10 - 12, 30 - 32, 40 - 42, 50 |
| Class 3  | | | **Level PM 0:** 28, 29 **Level PM 1:** 14, 16, 18, 21, 22, 25-29, 34, 35, 40, 41, 71, 77 | 30, 31, 36, 37, 42 - 52, 72 | 24, 44, 54, 70, 71 | **Level PMK 0:** 43, 53 **Level PMK 1:** 10-12, 20-22, 30-32, 33, 40-43, 50 53, 60, 61 |
| Class 4  | 01, 02, 14, 15, 18 - 70, -71 - 75- 77 | 16 - 55, 60, 61 70, 71, 80, 81, 83, 84, 90, 91- | **Level PM 1:** 27 [2], 49 - 52 **Level PM 2:** 30, 31, 36, 37, 42, 44-48, 70 **Level PM 3:** 32, 33, 38, 39, 43, 53-66 **Level PM 4:** 62 - 70 | 32, 33, 38, 39, 43, 53 - 70, 73 Independent of everything else, all Euro 5 cars | 34, 45, 55, 80, 81, 83, 84, 90, 91 | **Level PMK 1:** 44, 54 **Level PMK 2:** 10-12, 20-22, 30-33, 34, 40-44, 45 50-54, 55, 60, 61, 70, 71 **Level PMK 3:** 33-35, 44, 45, 54, 55, 60, 61 **Level PMK 4:** 33-35, 44, 45, 54, 55, 60, 61 |

[1] In the base of gas vehicles, after the Directive 2005/55/EG (previously 88/77/EWG)

[2] Cars with chassis number 27 e.g. 0427 and the text 96/69/ EG I with a gross vehicle weight of >2500 kg is after appendix 2 paragraph 1 No. 4 n) entitled to a Class 4 categorisation. This when it is proved that the car meets the requirements of the Level PM 1 of the appendix XXVI StVZO.

The full requirements for the DPF certification form Annexes of the main legislation on vehicle homologation and are available (in German). The original placing of these can be found on the internet at the sites below. A pdf of the particulate trap certification can also be found in Annex 2a.

- DPF certification for cars and light duty (http://www.gesetze-im-internet.de/stvzo/anlage_xxvi_164.html) also has 5 annexes, which from the main page (http://www.gesetze-im-internet.de/stvzo, search for XXVI).
- DPF certification heavy duty http://www.gesetze-im-internet.de/stvzo/anlage_xxvii_170.html.

## 17. Annex 4a A separate dpf file of the particulate trap certification (in German)

**English translation of the Italian DPF certification scheme**

# Transport *Ministry*

## THE MINISTER FOR TRANPORT

acting in agreement with

## THE MINISTER FOR THE ENVIRONMENT AND FOR LAND AND SEA CONSERVATION

and

## THE MINISTER FOR HEALTH

Provisions concerning the approval and installation of systems for reducing the particulate mass released by compression ignition engines used in motor vehicles.

Having regard to Article 71 of Legislative Decree no. 285 of 30th April 1992, which confers on the Minister for Transport the authority to issue decrees, in agreement with the Minister for the Environment and with the Minister for Health, relating to rules on the design and operation of motor vehicles and their trailers;

Having regard to Article 78 of said Legislative Decree no. 285/1992 and Article 236 of the Presidential Decree no. 495 of 16th December 1992 implementing the Highway Code, concerning alterations to the design features of road vehicles and the updating of vehicle registration log-books;

Having regard to the decree of the Minister for Transport of 5th August 1974, published in the Official Gazette of the Italian Republic no. 251 of 26th September 1974, on the rules for partial EEC approval of motor vehicle types with regard to the pollution produced by diesel engines in vehicles, as referred to in Directive 72/306/EEC and subsequent amendments and supplements thereto;

Having regard to the decree of the Minister for Transport and Navigation no. 277 of 2nd May 2001, published in the Official Gazette of the Italian Republic no. 160 of 12th July 2001, which brought in the rules entitled “Provisions concerning the approval procedures for motor vehicles, trailers, agricultural tractors, machinery and public works vehicles and their systems, components, and technical features” and subsequent amendments and additions thereto;

In consideration of the need to enable the adoption of measures that reduce emissions of pollutants of road vehicles through the use of systems for reducing particulate mass released by compression ignition engines used in motor vehicles;

Having fulfilled the notification procedure regarding technical rules and regulations laid down un Law no. 317 of 21st June 1986, as amended and supplemented by Legislative Decree no. 427 of 23rd November 2000;

Having regard to paragraphs 3 and 4, Article 17, of Law no. 400 of 23rd August 1988;

Having heard opinion no. 3144/2007 of the Council of State, expressed by the consultative office for regulatory instruments in its meeting of 27th August 2007;

Having regard for the memorandum from the Prime Minister, in accordance with paragraph 3, Article 17, of Law no. 400/88, in notice no. 16896 of 23rd October 2007:

## *Adopts*

the following regulations

ARTICLE 1

*Scope of application*

1. These regulations shall apply to systems for reducing the particulate mass produced by compression ignition engines approved in accordance with Directive 88/77/EEC and subsequent amendments and additions thereto or with equivalent UNECE regulations, intended for fitting to road vehicles that are in service.

2. The systems referred to in paragraph 1 shall be approved in accordance with the requirements of theses regulations and with reference to the testing procedures set out in Directive 88/77/EEC and subsequent amendments and supplements thereto or with equivalent UNECE regulations.

ARTICLE 2

*Definitions*

1. For the purposes of these regulations:

a) *"system" for reducing particulate mass* shall mean one or more elements functionally interconnected with the engine, or with its intake or exhaust devices, or with its fuel supply and control system,

b) "*engine-type classes*" - normally defined on the basis of compliance with the exhaust emission limits adopted in the European Community - shall mean the following groups:

aa) Euro 0 – engines in this class are not approved for pollution purposes, or were approved before directive 91/542/EEC came into force;

bb) Euro1 – engines in this class are approved in accordance with Directive 91/542/EEC, line A;

cc) Euro 2 – engines in this class are approved in accordance with Directive 91/542/EEC, or 96/1/EED, line B;

dd) Euro 3 – engines in this class are approved in accordance with Directives 1999/96/EC and 2001/27/EC, line A;

ee) Euro 4 – engines in this class are approved in accordance with Directives 1999/96/EC and 2006/51/EC, line B1;

ff) Euro 5 – engines in this class are approved in accordance with Directives 1999/96/EC and 2006/51/EC, line B2;

Annex A tabulates the limit values for particulate mass emissions adopted in the European Community for the classes indicated above.

c) "*family of engine types*" shall mean a set of engine types identified on the basis of the parameters set out in point 1 of Annex C;

d) "*parent engine*" shall mean an engine belonging to a given family of engine types that is regarded as being representative of that family on the basis of the parameters set out in point 2 of Annex C;

f) "*manufacturer*" shall mean the producer of a system for reducing the particulate mass emitted by an engine.

ARTICLE 3

*Approval of systems*

1. Approval applications for systems shall be submitted by the manufacturer or by the representative of the latter, appropriately accredited, to the motor vehicle testing centre in accordance with the manner indicated in the decree of the Ministry for Transport and Navigation no. 277 of 2nd May 2001. The application shall be supported by a data sheet filled out in accordance with the sample sheet shown in Annex B.

2. The following must be stated in the application:

a) the family of engine types for which the system is intended, as well as the original class for the engines (Euro…..) as determined by their compliance with the corresponding exhaust emission levels;

b) the class in which inclusion is sought for the family of engine types, following fitting of the system, for the sole purposes of particulate mass pollution.

3. Each system shall be approved, with possible approval extensions, with respect to one or more engine families. The check on the suitability of the system for the purposes of its approval shall be carried out on the basis of the criteria and applying the procedures listed in Annex D.

4. With respect to each engine type making up the family, the manufacturer shall also declare that:

a) it is performing the required testing procedures on the system durability, in accordance with the content of Annex E;

b) installation of the system shall not entail a breach of the maximum values allowable for the exhaust back pressure during any operating stage of the engine.

5. Each type of system that is approved in conformance with the requirements of these regulations shall be assigned an approval/approval-extension number, in accordance with the provisions of Annex IV to the decree of the Ministry for Transport and Navigation no. 277 of 2nd May 2001.

6. The Head Office of the Traffic Control Authority (*Direzione Generale per la motorizzazione*) shall issue an approval certificate for the system drawn up in accordance with the sample certificate shown in Annex F.

ARTICLE 4

*General characteristics of the systems*

1. The prior authorisation is required from the manufacturer of the motor vehicle, or of the manufacturer of the engine, where these are not one and the same manufacturer, for systems that are functionally connected to one or more of the following elements:

a) electronic devices for managing fuel supply and, possibly, for checking on combustion and monitoring emissions;

b) the assembley of components for the fuel feed to the engine (excluding the fuel tank and respective tubing);

c) traction motor

d) EGR system.

2. The system shall provide an alarm device for excessive exhaust back pressure that signals when the level of clogging is critical.

3. Technical solutions that, through by-pass devices, provide for the exclusion or the shutting of the system shall not be allowed.

4. For systems that use special additives or chemical reagents, the manufacturer shall:

a) provide automatic additive-input systems;

b) provide for the vehicle to be fitted with a device for signalling the absence of the additive;

c) declare that the use of these products does not damage the vehicle or the engine;

d) append to the approval documentation the safety data sheet for the additives or chemical reagents used;

e) provide information as to any metal emissions produced through using the additives or chemical reagents;

f) provide instructions as to the effects that a lack or excess of the additive or chemical reagent can have for the system or the engine;

g) state the action to be taken in order to ensure proper use on the part of the user;

h) state that the quality of the fuel, following input of the additives, shall remain consistent with the requirements of Standard EN 590 as well those of the existing standards in relation to health and environmental protection.

ARTICLE 5

*Inclusion of engines [in engine-type class] solely for the purposes of particulate mass pollution*

1. Fitting a system that is recognised as suited to a type of engine has the effect, solely for the purposes of particulate mass pollution, of securing the inclusion of that type of engine in the class requested in the application approval, as referred to in point b, paragraph 2 of article 3.

ARTICLE 6

*Stipulations concerning the fitting of systems to motor vehicles in service*

1. The Transport Control Authority Offices, at the request of users, shall examine individual vehicles to check that the system fitted conforms to the approved type.

2. The person carrying out the fitting will provide a declaration in which they certify compliance with the fitting instructions given by the manufacturer or, in the cases provided for in paragraph 1 of article 4, by the manufacturer of the motor vehicle or of the engine.

ARTICLE 7

*Updating of vehicle registration log-book*

1. Following the examination referred to in article 6, and subject to its satisfactory outcome, the Transport Control Authority Offices shall update the vehicle registration log-book by entering a note in it worded as follows:

"Vehicle provided with a system for reducing particulate mass, with approval mark…… For the purposes solely of particulate mass pollution, it is classed as Euro…….".

ARTICLE 8

*Stipulations for the manufacturer of the system*

1. All approved systems shall display the mark of the approval attained, which shall be clearly legible and indelible and show the numbering indicated in paragraph 6 of article 3. Said mark shall be affixed directly on one of the elements forming the system or through a plate that is integral with said element, fitted to the exhaust system.

2. With each unit the manufacturer shall provide the instructions for its fitting, as indicated in article 6, inclusive of general guidance and any specific instructions.

3. Each single system produced shall be provided complete with information for the user regarding use and maintenance. Said information shall extend to the characteristics of the fuels that may be used with each system, such as the sulphur content.

ARTICLE 9

*Conformity of production*

1. Manufacturing plants for the systems shall be subject to monitoring under the conformity of production inspection system referred to in the managerial decree (*decreto dirigenziale*) of 25th November 1997.

2. Approved systems shall be made in such a manner that they are consistent with the approved type.

3. The Head Office of the Transport Control Authority may undertake any test provided for in the regulations when verifying:

a) the conformity of production of the system;

b) the procedures for assessing the durability of the system.

4. The approval granted for a type of system shall be annulled in the event of non-compliance with the stipulations in this article.

ARTICLE 10

*Recognition of approved systems by Member States of the European Union*

1. Systems approved in other Member States of the European Union, by Turkey, or other members of the European Economic Area, complete with suitable documentation issued by one of the above-listed states, shall be subject to a check on the safety conditions of the product and the protection of the users on the basis of the certificates issued by the country of origin.

2. Where a documentary examination reveals that the safety conditions of the product and for the protection of the users is equivalent or superior to those stipulated in the regulations, the check referred to in paragraph 1 shall not entail a repetition of the checks already performed as part of the original approval procedure.

This decree, bearing the seal of State, shall be included in the Official Compendium of the Law-making Instruments of the Italian Republic. There is a duty on all to comply therewith and to ensure compliance therewith.

Rome,

The Minister for Transport

[initials – illegible]

The Minister for the Environment and for Land and Sea Conservations

(Alfonso Pecoraro S??? - not entirely legible)

The Minister for Health

# Annex A

Table showing limit values for emissions of particulate mass matching the classes of engine types approved in accordance with directive 88/77/EEC and subsequent amendments and supplements thereto.

| Engine type classes | Limit value for particulate mass (g/kWh) |
|---|---|
| Euro 1 | 0.36<br>In the case of engines of power ≤ 00kW, a coefficient of 1.7 is attributable to the limit value |
| Euro 2 | 0.15 |
| Euro 3 | 0.10 |
| Euro 4 | 0.02 |
| Euro 5 | 0.02 |

## **Annex B** Sample data sheet

Information sheet regarding approval of an exhaust system

for reducing particulate mass

*The following information, where applicable, is to be provided in triplicate.*

*Any drawings and photographs are to be provided in an adequate scale and with sufficient detail in A4 format or sheets folded in that format.*

*Where the systems include electronically controlled functions, the necessary information on their performance is to be provided.*

0. GENERAL DATA

0.1 Make (name of undertaking)……

0.2 Type……..…..

0.3 Name and address of the manufacturer……..…..

0.4 Position and method of affixing the approval mark……..…..

0.5 Name and address of facility, or facilities, where fitting was done……..…..

1. DESCRIPTION OF THE SYSTEM

1.1 Make and type of system……..…..

1.2 System drawings: ……..

1.2.2 Description of operating principle of system……..…..

1.2.3 Type of additive or chemical reagent used……..…..

1.2.4 Temperature range for operation of the system……..

1.2.5 Description of the device for checking clogging of system……..…..

1.3 Description of the type or types of vehicle/engine for which the system is intended……

1.3.1 Number(s) and/or symbol(s) that identify the type or types of engine or vehicle……..

1.4 Description and drawings that show the position of the particulate-mass reduction system in relation to the engine…….

1.5 Observations……

## **Annex C** Parameters that define a family of engine types

Criteria for the choice and validation of the parent engine

1) Parameters that define a family of engine types

The parameters that define a family of engine types are listed hereunder:

a) engine type class (EURO……..);

b) number of cylinders;

c) individual cylinder displacement (the engines must fall within a maximum variation range of -20% with respect to the parent engine);

d) method of air intake.

2) Criteria for the choice and validation of the parent engine

The choice of parent engine is made on the basis of the criteria stated in point 8.2 of annex 1 of Directive 2005/55/EC.

The validation of the parent engine for the purposes of the procedure for verifying the suitability of the system provides for the verification of the values of the pollutant emission parameters (CO, HC, NOx, PT) logged using the same test method laid down by the standards in force at the time of approval of the engine.

Said values must fall within a tolerance range of not more that 20% with respect to the corresponding pollution limit values set by the rule under which the engine to be validated was approved.

## Annex D

Procedure for checking the suitability of a system for the purposes of its approval

1) The procedure for checking on the suitability of the particulate-mass reduction system shall be carried out by recording the pollutant emission values of the parent engine that is representative of the engine family (see Annex C).

2) The pollutant emission tests shall be carried out in sequence both on the parent engine without the system and on the same engine when fitted with it, in accordance with the relevant instructions of the rule applicable to the engine class in which inclusion is being sought. The tests shall be conducted with the system positioned at a distance of at least 2.00 m from the engine output. A lesser distance is allowed if the applicant for approval shows that the system, during the type of duty which the vehicle performs, may be fitted at that distance.

3) In the case of systems that make use of intermittent regeneration techniques (systems for which a regeneration process is provided), the sequence of emission tests must be correspond to the following pattern:

a) a test with the system as new

b) a test with the filter system element in a state that is almost critical (prior to regeneration).

The average of the values measured in the two tests is taken as the final level of the particulate mass.

4) The system is to be deemed suitable if the following conditions are satisfied:

a) the value for the particulate mass obtained when the engine has been fitted with the system, using the test procedures referred to in point 2, is below the limit for the class in which inclusion is sought;

b) the emission values of the gas pollutants (CO, HC) obtained when the engine is fitted with the system must not exceed the corresponding values recorded during the test performed when the engine is without the system;

c) the emission value of the gas pollutants (NOx) obtained when the engine is fitted with the system must not exceed the corresponding value recorded during the test performed when the engine is without the system. For the purposes of the procedure the emission value of $NO_2$ obtained when the engine is fitted with the system must not exceed thirty percent of the total emission value for NOx obtained under the same conditions;

d) the value for smoke ($m^{-1}$), where applicable, obtained when the engine is fitted with the system using the test procedures indicated in point 2, shall be below the limit for the class in which inclusion is sought;

e) the specific fuel consumption recorded in the test indicated in points 2) and 3) with the system fitted must not exceed the corresponding value recorded without the system by more than 4%.

## Annex E Procedure for testing system durability.

1) The test of durability is based on carrying out a program aimed at accumulating particulate in the system.

At the option of the manufacturer, this can be carried out:

- by making the motor vehicle, fitted with the parent engine type and corresponding system, travel a distance of not less than 100,000 km;

or

- by submitting the same engine type and corresponding system to an accumulation schedule on a dynamometer lasting not less than 2,000 hours.

2) The manufacturer shall take account of the operating conditions that are the basis for carrying out the accumulation schedule.

It shall also specify when the particulate emissions must be checked; there shall, in whatever case, be an initial and a final test where so provided in the rule applying to the engine class in which inclusion is being sought.

3) The schedule shall be described in detail in the approval application for the system. The authority that grants approval may order changes and additions to the schedule.

The results of the emission tests, carried out during the schedule, shall be made available to the authority that grants approval.

4) At the end of the schedule the variation in the value of particulate mass shall not, for the purposes of the procedure, exceed the corresponding value obtained in the initial test – see point 2 – by more than 20%.

5) The scheduled maintenance of the system and of the parent engine shall be carried out in compliance with the provisions set out in point 4.1 of Annex 2 of Directive 2005/78/EC of the Commission of the EU.

## **Annex F:** Sample approval/approval-extension certificate

*Department for Land Transport*

*Traffic Control Authority Head Office*

*…….. Office*

CERTIFICATE concerning

Approval/approval extension for a system for reducing the particulate mass produced by compression-ignition engines

N.……

Having regard to the new highway code, as approved in Legislative Decree no. 285 of 30/04/1992 and subsequent amendments and additions thereto;

Having regard to the Regulations for Carrying Out and Implementing the Highway Code, approved through Presidential Decree no. 495 of 16/12/1992 and subsequent amendments and additions thereto;

Having regard to the Decree of the Minister for Transport and Navigation no. 277 of 2nd May 2001 and subsequent amendments and additions thereto setting out the rules on the administrative procedures for approval;

Having regard to the Decree of the Minister for Transport of …… setting out the provisions regarding the approval of systems for reducing the particulate mass produced by compression-ignition engines used in motor vehicles;

Having regard for the application submitted on ……. by …… to obtain approval for the type of system designated as ……;

Having taken note of approval……;

Having taken note of report no…… dated ……. drawn up by the Vehicle Testing Centre of ……..;

Approval is hereby declared with respect to the system type:

0.1 make (name of undertaking)……..

0.2 type……

0.3 parameters that define the engine family ……..

0.3.1 engine-type class of the engine types ……..…….

0.3.2 number of cylinders ……..……

0.3.3 individual cylinder displacement (minimum and maximum value)…….

0.3.4 method of air intake……..……

the fitting of which, solely for the purposes of particulate mass pollution, shall secure inclusion of the engines types defined in accordance with the parameters in point 03 in the EURO…….. class.

Systems manufactured must conform to the type approved and must show the approval mark referred to in paragraph 5, article 3 of the Decree of the Minister for Transport of ……..

……., on ……

## 18. Annex 5. Further details on exemptions

Generally there are five main types of exemption:

- for key roads (legally required)
- for specific low mileage specialist or military etc vehicles (widely used)
- hardship exemptions (useful to minimise socio-economic impact)
- interim exemptions (where little notice of LEZ implementation is given)
- specific journeys or temporary exemptions (give the potential for wide ranging exemptions with a high administrative burden)

In a number of these categories, for example specific vehicles and journeys, a wide range of approaches have been taken, from a case-by-case minimum list to a very much more relaxed approach. Needless to say, the more exemptions the less impact the LEZ has.

### 18.1. Specific vehicles

These range from the case-by-case minimum list in Denmark:

- If the installation of a DPF will affect the safety of the vehicle, or if there are special circumstances where environmental health can be considered of secondary importance.
- “in special cases” with the DPF requirement may be dispensed with.

To specific targeted lists in Germany and the Netherlands. The Dutch exemptions are nationally agreed and centrally administered. A 'rural exemption' was until in place until January 2009 for special vehicles and special categories of vehicles (often identified through the national vehicle database). From August 2009, the following national exemptions are allowed:

- Special vehicles
  - Crane / Crane Vehicle
  - Platforms
  - Mixer / Concrete mixer
  - Car Suction / Suction
  - Fire engine
  - Mobile shops
  - Street cleaners
  - Armoured vehicles
  - Exceptional transport
- Vehicles 100% bio-diesel as they cannot be retrofitted.
- An uncertified DPF if a certified DPF does not exist.
- Vehicles where no DPF is available, or certified or technically not able to be fitted
- Removal lorries
- Hardship cases (see section 3.6)

In Germany the national exemptions for specific vehicles are:

- mobile machinery and equipment;
- work machines;
- agricultural and forestry tractors;
- two- and three-wheeled motor vehicles incl. "quads";
- ambulance cars, doctor's cars with the mark "Arzt Notfalleinsatz" (doctor in emergency service);

- motor vehicles driven by, or carrying persons with serious mobility impairments, helpless or blind persons who have a severe disablement document marked with disability codes "aG", "H" or "Bl";
- vehicles that may use special priority privileges, such as police, fire brigade, disaster relief or refuse collection vehicles;
- Army and NATO[32] vehicles.
- Vintage cars older than 30 year with “H” in the registration number or with a red number plate (prefix 07) for historic vehicles. Foreign vehicles need to comply with the corresponding conditions.

The range of German local exemptions is wide, from Berlin with none except for the hardship exemptions, to others that are fairly extensive, but reducing over time. Often they are only available if the vehicle cannot be retrofitted. One example of a fairly long list of exemptions, including interim exemptions, is Münster which implemented with a short notice period, which are given below. Three-day exemptions can also be purchased for a private car 10€, commercial use 25€, each plus postage if posted. Having these exemptions would not be considered best practice, better would be to give adequate warning before implementing the LEZ, and not getting the idea of extensive exemptions to be expected.

To get an exemption, one of the following must be the case:

- retrofitting of the vehicle is not technically possible because such a system is not currently available in the market or the retrofit is not economically feasible
- a replacement vehicle has been ordered, but delivery has not yet occurred and the delay is not the fault of the person who ordered the replacement.

Exemptions until 31 December 2010 (extended to 30/6/2011)

- All vehicles with parking permits for Trade, Commerce and Businesses under the ‘Runderlasses III B-3-78-12/2’ of the Building and Traffic ministry from 16th April 2007. The permit, or that for disabled drivers, should be clearly displayed in the vehicle.
- Diversions signed from the exempted motorway
- These exemptions are issued by the town of Münster. Where the LEZ authorities have mutual recognition agreements with Münster, then these exemptions will also be valid there.

Exemptions valid until 30.06.2010

- Residents, if their main residence is inside the LEZ, a residents parking permit will be sufficient if an exemption has not been applied for.
- Businesses inside the LEZ.

Exemptions – valid until 31.12.2010 at the latest (extended to 30/6/2011)

- Buses that operate in the public interest, (e.g. public buses, school transport, travelling to exhibitions and events, individual cases of vehicle access). The length of exemption is dependent on the need. This exemption must be paid for.

Exemptions – for a period of 6 months

- Distribution of important goods and services to the population, in particular:
- Requirements of food shops
- Requirements of Pharmacies
- Requirements of old peoples homes, hospitals and other public facilities
- Requirements of weekly markets
- Travel to undertake essential services, in particular trips:
- To repair and maintain technical equipment needed for operations
- To deal with damage to buildings, including the removal of water, gas and electrical damage
- For social and nursing support services,
- To exercise overwhelming and urgent interests of individuals, especially for:
- The need for doctor visits (e.g., dialysis patients and others)
- Shift work for those of who are not able to use public transport or a bicycle

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- The maintenance of manufacturing and production processes, such as:
- The supply and disposal of construction sites
- Goods delivered to manufacturing plants and shipping of goods from the production plant for operational purposes including the transport, if alternatives are not available

Short term exemptions for other public interest reasons, such as:

- Passing through of heavy loads
- Reaching exhibitions or events

Exemption for special vehicles

- A special permit be granted for a period of 5 years may be available for special vehicles that because of their special technical features (e.g., test van, media special-purpose vehicles), if it can be proved that there will be no retrofit available long term and a replacement compliant vehicle is not economically feasible.
- For the direct marketing of agricultural products

### 18.2. Hardship exemptions

In Hannover the income limits for the hardship exemptions are set as:

- With no dependants €1130 per month
- With 1 dependants €1560 per month
- With 2 dependants €1820 per month
- With 3 dependants €2110 per month
- With 4 dependants €2480 per month
- With 5 dependants €3020 per month

### 18.3. Specific journeys

Some cities in Germany and Italy – those affecting private cars - have local exemptions for those who work shifts when public transport is not available. Other local exemptions in particularly some Italian cities include deliveries of foodstuffs, pharmacies, social care, loading and unloading to shops in the LEZ, representatives and commercial agents, family and carers of persons in need who live in the LEZ etc..... These long lists of exemptions are not considered good practice, as increase the complexity of the LEZ and reduce the impact and credibility.

### 18.4. Interim and temporary exemptions

Temporary exemptions are available in the Netherlands if a vehicle enters an LEZ less than 12 days a year. This will be enforced by manual or camera enforcement, depending on the enforcement in the city. In London vehicles can effectively buy a daily exemption by paying the (£200 for heavy duty, and it will be £100 for light duty vehicles from their inclusion in 2012) daily charge, but this is rarely used.

Interim exemptions have been used in Germany, as in the Münster example above, where there has not been much notice of the LEZ implementation given. It is naturally better to give at least a years notice of LEZ implementation.

### 18.5. Number of exemptions

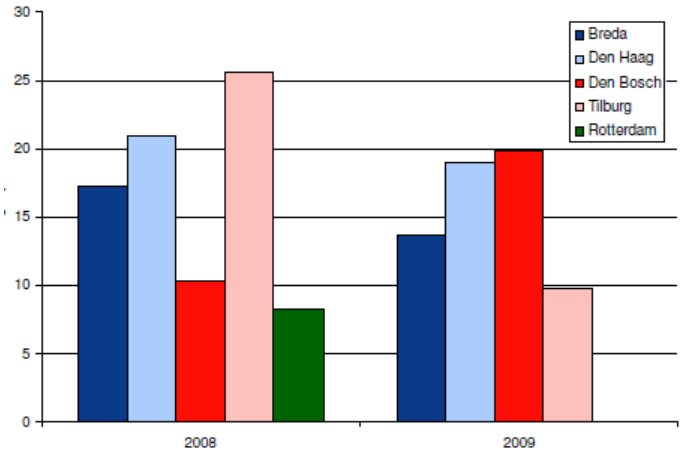
The number of exemptions approved varies, depending on the approach taken by the city. For example, Berlin sold 1.22 million stickers[33], and around 100,000 Berlin vehicles are no longer allowed in the city centre. In Berlin, 6,000 were applied for (up to 4.6.2009). Up to 1.1.2010 there were 44,600 issued for passenger cars, 33,250 for commercial vehicles, a total of around 78,000, of which 7200 gained a hardship exemption, 4200 vehicles could still drive for some months because of delayed availability or delivery of retrofit DPF systems. In addition 13,535 vehicles with a yellow sticker could still drive for a year with a certificate issued by the vehicle inspection centres in the event that no filter system for the vehicle could be found in the German-wide filter data base. The latter option was set up as a result of an initiative by the German association of vehicle inspection centres in collaboration with the Federal road transport agency and filter manufacturers (see www.feinstaubplakette.de, the public web-portal of the data base).

33 sold from the town itself (more were purchased elsewhere)

As of 21.10.2009, Mannheim granted 500 exemptions. For the first year, 1,000 residents and businesses in Bottrop, Gelsenkirchen and Recklinghausen (joint population 524,000) had exemptions for the first year.

During 2009, 41% of HGVs did not comply with the standards in the Dutch LEZs, 10% of which had a rural or municipal exemption (and of this 10%, hardship exemptions accounted for 3%, 7% other rural or municipal exemptions).

**Figure 14. No. exemptions granted per month for various Dutch cities in 2008/09**[34]




German legislation regulating the requirements of the sticker. Pages 1-28 are the original order, pages 29-45 an ammending order/

34 2009 Dutch annual LEZ monitoring report. Multiply by 12 to get the total exemptions per year.

## 19. Annex 6 German sticker regulations

Order enacting and amending provisions on the marking of low-emission motor vehicles*

of [date]

The following is decreed by

- the Federal German Government, on the basis of Section 40(3) of the Federal Emissions Protection Act in the version published on 26 September 2002 (Federal Law Gazette I p. 3830), and following consultation with the parties involved, and

- the Federal Ministry of Transport, Building and Urban Development and the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, on the basis of Section 6(1) point 3(d) und point 5a, in each case read in conjunction with subsection 2a, of the Road Traffic Act in the version published on 5 March 2003 (Federal Law Gazette I p. 310, 919), read in conjunction with Section 1 of the Act on the adaptation of jurisdiction of 16 August 2002 (Federal Law Gazette I p. 3165) and the Decree for the establishment of administrative and legal institutions of 22 November 2005 (Federal Law Gazette I p. 3197).

Article 1

[...] Order enacting the
Federal Emissions Protection Act

(Order on the marking of low-pollution
motor vehicles – [...] German designation: BImSchV)

Section 1

Area of application

(1) The present Order governs exemptions from road-use bans pursuant to Section 40(1) of the Federal Emissions Protection Act and the classification of motor vehicles into pollutant classes and also lays down requirements to be met in the marking of vehicles. The Order applies to category M and N motor vehicles in accordance with Annex II A points 1 and 2 of Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers (OJ L 42 p. 1), most recently amended by Directive 2005/64/EC of the European Parliament and of the Council of 26 October 2005 (OJ L 310 p. 10).

(2) The competent authority, and in undeferrable cases the police, may permit the road use of vehicles not marked in accordance with Section 3 to and from particular facilities where this is in the public interest, in particular where necessary for the supply of the population with essential goods and services or where overriding and undeferrable interests of individuals so require, in particular where manufacturing and production processes could not otherwise be maintained.

Section 2

Classification of motor vehicles into pollutant classes

(1) Motor vehicles marked by means of a sticker in accordance with Annex 1 shall be exempt from road-use bans in the sense of Section 40(1) of the Federal Emissions Protection Act insofar as this is stated on a relevant road sign.

(2) Motor vehicles are classified into pollutant classes 1 to 4 according to their emissions of pollutants. The details of classification of motor vehicles into the pollutant classes can be found in Annex 2.

(3) Motor vehicles listed in Annex 3 shall be exempt from road-use bans in the sense of Section 40(1) of the Federal Emissions Protection Act even if they are not marked with a sticker pursuant to subsection (1).

* The obligations arising from Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on Information Society services (OJ L 204 p. 37), as amended by Directive 98/48/EC of the European Parliament and of the Council of 20 July 1998 (OJ L 217 p. 18), have been met.

Section 3

Marking

(1) Non-reusable non-fading and forgery-proofed stickers according to the design given in Annex 1 shall be used for the marking of motor vehicles according to pollutant classes 2 to 4. The pollutant class shall be marked by means of the pollutant class number specified on the sticker and the corresponding colour thereof. The colour of the sticker shall be as follows: red for pollutant class 2 motor vehicles, yellow for pollutant class 3 motor vehicles and green for pollutant class 4 motor vehicles.

(2) The mark for the vehicle in question shall be entered in the appropriate field on the sticker by the competent issuing body using non-fading ink. In order to mark a motor vehicle, the sticker shall be affixed to the inside of the windscreen such that it is clearly visible. The sticker must be so designed and affixed that it self-destructs on removal from the windscreen.

Section 4

Issuing of the stickers

The bodies issuing the stickers shall be approval authorities or other competent authorities under *Länder* law and the bodies accredited for the performance of exhaust-gas examinations in pursuance of Section 47a(2) of the Road Traffic Approval Order. This shall also apply to motor vehicles within the meaning of Section 1 of the Order on international motor vehicle traffic, in the version revised and published in Federal Law Gazette Part III, volume 9232-4, most recently amended by Article 3 of the Order of 9 August 2004 (Federal Law Gazette I p. 2092).

Section 5

Documentary proof of pollutant class for vehicles authorised in Germany

(1) The documentary proof of the classification of a vehicle into a particular pollutant class shall be provided

1. by means of the emissions-based code number entered in the approval certificate Part I / in the vehicle certificate and in the vehicle registration document,

2. for motor vehicles falling within the scope of the regulations of the Motorway Toll Act for heavy goods vehicles in the version published on 2 December 2004 (Federal Law Gazette I p. 3122), by means of certificates pursuant to Sections 8 and 9 of the Goods Vehicle Toll Order of 24 June 2003 (Federal Law Gazette I p. 1003).

(2) The Federal Ministry of Transport, Building and Urban Development shall publish in the Transport Gazette the assignment of the emissions code numbers stated in the vehicle documentation to their respective pollutant classes.

Section 6

Documentary proof of pollutant class for vehicles authorised abroad

(1) For vehicles authorised abroad and falling within the scope of the regulations of the Motorway Toll Act for heavy goods vehicles in the version published on 2 December 2004 (Federal Law Gazette I p. 3122), documentary proof of classification into a pollutant class may be provided by means of certificates pursuant to Sections 8 and 9 of the Goods Vehicle Toll Order of 24 June 2003 (Federal Law Gazette I p. 1003).

(2) In the case of vehicles authorised abroad it is assumed, in accordance with subsections (3) and (4), that they fall within the pollutant classes listed there if no documentary proof can be provided for such vehicles of their compliance with the requirements under

1. Council Directive 70/220/EEC of 20 March 1970 on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from positive-ignition engines of motor vehicles (OJ L 76 p.1) in the relevant applicable version in each case, or

2. Council Directive 88/77/EEC on the approximation of the laws of the Member States relating to measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles (OJ L 36 p. 33) in the relevant applicable version in each case.

(3) Motor vehicles with compression-ignition engines of categories M and N shall be classified in:

1. pollutant class 1,

if they do not fall within pollutant classes 2 to 4,

2. pollutant class 2,

a) if they fall within the scope of Directive 70/220/EEC and were first authorised after 31 December 1996 but before 1 January 2001,

b) if they fall within the scope of Directive 88/77/EEC and were first authorised after 30 September 1996 but before 1 October 2001,

3. pollutant class 3,

a) if they fall within the scope of Directive 70/220/EEC and were first authorised after 31 December 2000 but before 1 January 2006,

b) if they fall within the scope of Directive 88/77/EEC and were first authorised after 30 September 2001 but before 1 October 2006,

4. pollutant class 4,

a) if they fall within the scope of Directive 70/220/EEC and were first authorised after 31 December 2005,

b) if they fall within the scope of Directive 88/77/EEC and were first authorised after 30 September 2006,

c) if they fall within the scope of Directive 70/220/EEC, comply with the requirements of Directive 98/69/EC, Directive 1999/102/EC, Directive 2001/1/EC, Directive 2001/100/EC, Directive 2002/80/EC or Directive 2003/76/EG and can provide documentary proof (such as by means of a manufacturer's certificate) that they do not exceed the particle limit value of 5.0 mg/km* given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive.

(4) Motor vehicles with positive-ignition engines of categories M and N shall be assigned to pollutant class 4 if they fall within the scope of Directive 70/220/EEC and were first authorised after 31 December 1992.

Annex 1

(Re Sections 2(1) and 3(1))

Sticker design

| | **Pollutant class 2** | **Pollutant class 3** | **Pollutant class 4** |
|---|---|---|---|
| Diameter of the sticker 80 mm,<br>black border of coat thickness 1.5 mm<br><br>Pollutant class number:<br>Height 35 mm<br><br>Text field:<br>60 x 20 mm<br><br>Text:<br>jet black RAL 9005, using non-fading ink |  |  |  |

. The particle limit value specified in the Particulate Matter (PM) column of table 1 of Annex 1 to the Commission proposal for a Regulation of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions and on access to vehicle repair information, amending Directive 72/306/EEC and Directive ../../EC (Council Document No 5163/06 of 10 January 2006).

| | | | |
|---|---|---|---|
| Sticker colour: | traffic red<br>RAL 3020<br>non-fading | traffic yellow<br>RAL 1023,<br>non-fading | traffic green<br>RAL 6024,<br>non-fading |
| Text field: | pure white RAL 9010, black border | pure white RAL 9010, black border | pure white RAL 9010, black border |

The pollutant class number shall be displayed in accordance with the text pattern of Annex V page 3 of the Road Traffic Approval Order.

The colouring of the base, the border and the text shall be taken from the RAL 840-HR colour chart published by RAL Deutsches Institut für Gütesicherung und Kennzeichnung e.V., Siegburger Str. 39, 53757 St. Augustin, Germany.

Annex 2

(Re Section 2(2))

**Classification of motor vehicles into the pollutant classes**

(1) Motor vehicles with compression-ignition engines of categories M and N shall be classified into pollutant classes 1 to 4 according to their emissions of pollutants, as follows:

Pollutant class 1 motor vehicles: those which

1. do not fall within pollutant classes 2 to 4.

2. Pollutant class 2 motor vehicles: those which

(a) fall within the scope of Directive 70/220/EEC as amended by Directive 94/12/EC of the European Parliament and of the Council of 23 March 1994 (OJ L 100 p. 42) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values laid down for category M with a permissible total mass of no more than 2500 kg to be found in the table contained in point 5.3.1.4 of Annex I, or which

(b) fall within the scope of Directive 70/220/EEC as amended by Directive 96/44/EC of the European Parliament and of the Council of 1 July 1996 (OJ L 210 p. 25) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values laid down for category M with a permissible total mass of no more than 2500 kg to be found in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(c) fall within the scope of Directive 70/220/EEC as amended by Directive 96/69/EC of the European Parliament and of the Council of 8 October 1996 (OJ L 282 p. 64) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(d) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 98/77/EC of 2 October 1998 (OJ L 286 p. 34) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(e) fall within the scope of Council Directive 88/77/EEC on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous pollutants from diesel engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use

in vehicles (OJ L 36 p. 33) as amended by Council Directive 91/542/EEC of 1 October 1991 (OJ L 295 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values laid down in row B of the table contained in point 8.3.1.1 of Annex I to the Directive, or which

(f) fall within the scope of Directive 96/1/EC of the European Parliament and of the Council of 22 January 1996 amending Directive 88/77/EEC on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous and particulate pollutants from diesel engines for use in vehicles (OJ L 40 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values laid down in row B of the table contained in point 6.2.1 of Annex I to the Directive.

3. Pollutant class 3 motor vehicles: those which

(a) fall within the scope of Directive 70/220/EEC as amended by Directive 98/69/EC of the European Parliament and of the Council of 13 October 1998 (OJ L 350 p. 1) and which comply with the stipulations of this Directive and which do not exceed the limit values given under A (2000) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(b) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 1999/102/EC of 15 December 1999 (OJ L 334 p. 43) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(c) fall within the scope of Directive 70/220/EEC as amended by Directive 2001/1/EC of the European Parliament and of the Council of 22 January 2001 (OJ L 35 p. 34) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(d) fall within the scope of Directive 70/220/EEC as amended by Directive 2001/100/EC of the European Parliament and of the Council of 7 December 2001 (OJ L 16 p. 32) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(e) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 2000/80/EC of 3 October 2002 (OJ L 291 p. 20) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(f) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 2003/76/EC of 11 August 2003 (OJ L 206 p. 29) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(g) fall within the scope of Directive 88/77/EEC as amended by Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(h) fall within the scope of Directive 88/77/EEC as amended by Directive 2001/27/EC of the European Parliament and of the Council of 10 April 2001 (OJ L 107 p. 10) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which,

(i) by means of their fitting with a particulate matter reduction system, meet the requirements for category PM1 from Annex XXVI to the Road Traffic Approval Order, in the version published on 28 September 1998 (Federal Law Gazette I p. 1793), most recently amended by the Order of 27 January 2006 (Federal Law Gazette I p.287), with the exception of category M vehicles with a permissible total mass of greater than 2500 kg.

4. Pollutant class 4 motor vehicles: those which

(a) fall within the scope of Directive 70/220/EEC as amended by Directive 98/69/EC of the European Parliament and of the Council of 13 October 1998 (OJ L 350 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(b) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 1999/102/EC of 15 December 1999 (OJ L 334 p. 43) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(c) fall within the scope of Directive 70/220/EEC as amended by Directive 2001/1/EC of the European Parliament and of the Council of 22 January 2001 (OJ L 35 p. 34) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(d) fall within the scope of Directive 70/220/EEC as amended by Directive 2001/100/EC of the European Parliament and of the Council of 7 December 2001 (OJ L 16 p. 32) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(e) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 2002/80/EC of 3 October 2002 (OJ L 291 p. 20) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(f) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 2003/76/EC of 11 August 2003 (OJ L 206 p. 29) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B (2005) in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(g) fall within the scope of Directive 88/77/EEC as amended by Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B1 (2005) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(h) fall within the scope of Directive 88/77/EEC as amended by Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B2 (2008) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(i) fall within the scope of Directive 88/77/EEC as amended by Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under C (EEV) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(j) fall within the scope of Directive 88/77/EEC as amended by Directive 2001/27/EC of the European Parliament and of the Council of 10 April 2001 (OJ L 107 p. 10) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B1 (2005) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(k) fall within the scope of Directive 88/77/EEC as amended by Commission Directive 2001/27/EC of 10 April 2001 (OJ L 107 p. 10) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under B2 (2008) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(l) fall within the scope of Directive 88/77/EEC as amended by Commission Directive 2001/27/EC of 10 April 2001 (OJ L 107 p. 10) and which comply with the stipulations of this Directive and which, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under C (EEV) in tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

(m) by means of their fitting with a particulate matter reduction system, meet the requirements for category PM2 or category PM3 from Annex XXVI to the Road Traffic Approval Order, in the version published on 28 September 1998 (Federal Law Gazette I p. 1793), most recently amended by the Order of 27 January 2006 (Federal Law Gazette I p.287), or

(n) category M vehicles with a permissible total mass of greater than 2500 kg which, by means of their fitting with a particulate matter reduction system, meet the requirements for category PM1 from Annex XXVI to the Road Traffic Approval Order, in the version published on 28 September 1998 (Federal Law Gazette I p. 1793), most recently amended by the Order of 27 January 2006 (Federal Law Gazette I p.287), or which

(o) meet the requirements for category PM5 from Annex XXVI to the Road Traffic Approval Order, in the version published on 28 September 1998 (Federal Law Gazette I p. 1793), most recently amended by the Order of 27 January 2006 (Federal Law Gazette I p.287), or which

(p) by means of their fitting with a particulate matter reduction system, meet the requirements for category PM4 from Annex XXVI to the Road Traffic Approval Order, in the version published on 28 September 1998 (Federal Law Gazette I p. 1793), most recently amended by the Order of 27 January 2006 (Federal Law Gazette I p.287).

(2) Motor vehicles with positive-ignition engines of categories M and N in pursuance of Annex II A points 1 and 2 of Council Directive 70/156/EEC shall be assigned to pollutant class 4 if they:

(a) fall within the scope of Directive 70/220/EEC as amended by Council Directive 91/441/EEC of 26 June 1991 (OJ L 242 p. 1), with the exception of such vehicles as are covered by the transitional provisions of Annex I point 8.1 or 8.3, and which comply with the stipulations of this Directive, or which

(b) fall within the scope of Directive 70/220/EEC as amended by Council Directive 93/59/EC of 28 June 1993 (OJ L 186 p. 21) and which comply with the stipulations of this Directive and which can document Type I testing (simulating the average tailpipe emissions after a cold start), or which

(c) fall within the scope of Directive 70/220/EEC as amended by Directive 94/12/EC of the European Parliament and of the Council of 23 March 1994 (OJ L 100 p. 42) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(d) fall within the scope of Directive 70/220/EEC as amended by Directive 96/69/EC of the European Parliament and of the Council of 8 October 1996 (OJ L 282 p. 64) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(e) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 98/77/EC of 2 October 1998 (OJ L 286 p. 34) and which comply with the stipulations of

this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(f) fall within the scope of Directive 70/220/EEC as amended by Directive 98/69/EC of the European Parliament and of the Council of 13 October 1998 (OJ L 350 p. 1) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(g) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 1999/102/EC of 15 December 1999 (OJ L 334 p. 43) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(h) fall within the scope of Directive 70/220/EEC as amended by Directive 2001/1/EC of the European Parliament and of the Council of 22 January 2001 (OJ L 35 p. 34) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(i) fall within the scope of Directive 70/220/EEC as amended by Directive 2001/100/EC of the European Parliament and of the Council of 7 December 2001 (OJ L 16 p. 32) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(j) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 2002/80/EC of 3 October 2002 (OJ L 291 p. 20) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive, or which

(k) fall within the scope of Directive 70/220/EEC as amended by Commission Directive 2003/76/EC of 11 August 2003 (OJ L 206 p. 29) and which comply with the stipulations of this Directive and which do not exceed the limit values laid down in the table contained in point 5.3.1.4 of Annex I to the Directive.

(3) Motor vehicles powered by means other than combustion engines (such as electric engines, vehicles powered by fuel cells) shall be assigned to pollutant class 4.

Annex 3

(Re Section 2(3))

**Exemptions from the marking obligation pursuant to Section 2(1)**

The following motor vehicles shall be exempt from road-use bans in the sense of Section 40(1) of the Federal Emissions Protection Act even if they are not marked with a sticker pursuant to Section 2(1):

1. mobile machines and equipment,
2. work vehicles,
3. agricultural or forestry tractors,
4. two or three-wheeled motor vehicles,
5. ambulances, doctors' vehicles bearing the appropriate marking and in use for the medical care of the population,
6. motor vehicles driven by or carrying persons of extreme mobility impairment or who are dependent upon the assistance of others or blind, such disability being indicated by the letter(s) "aG", "H" or "Bl", respectively, marked in their severe disablement documentation in accordance with Section 3(1) points 1 to 3 of the Order on severe disablement documentation,

7. vehicles for which special rights may be claimed pursuant to Section 35 of the Road Traffic Order,
8. the vehicles of non-German troops from states not signatory to the North Atlantic Treaty, in Germany in the course of military cooperation, insofar as they are used for journeys made for urgent military reasons,
9. civilian vehicles used in the service of the Federal Armed Forces, provided that the journeys in question are undeferrable and undertaken in order to carry out the sovereign duties of the Federal Armed Forces.

Article 2

Amendment to the Road Traffic Order

The Road Traffic Order of 16 November 1970 (Federal Law Gazette I p. 1565, 1971, I p. 16), most recently amended by Article 1 of the Order of 28 March 2006 (Federal Law Gazette I p. 569) is amended as follows:

1. Section 39(2) sentence 3 is worded as follows:

“The supplementary signs shall display black images or text on a white background with a red border, unless specified otherwise.”

2. Section 41(2) point 6 is amended as follows:

a) In the second sentence of the introductory part, the statement “260 or 270” is replaced by the statement “and 260”.

b) Sign 270 and the explanatory comments relating thereto are replaced by the following signs 270.1 and 270.2 and the explanatory comments relating thereto:

“Sign 270.1


[Key:
Umwelt ZONE = Environmental ZONE]

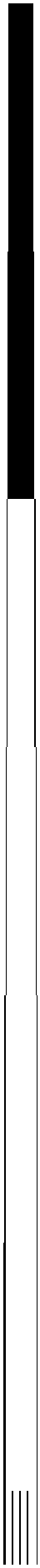
Start of a road-use ban for the purpose of reducing harmful air pollution within a zone.

Sign 270.2


[Key:
Umwelt ZONE = Environmental ZONE]

End of a road-use ban for the purpose of reducing harmful air pollution within a zone.

The signs 270.1 and 270.2 delimit the boundaries of a road-use ban zone. They ban the road use of motor vehicles within a road-use ban zone marked out in this way in the event of the putting into place of measures to reduce the harmful environmental impact of air pollution on the basis of Section 40(1) of the Federal Emissions Protection Act. The supplementary sign for sign 270.1



[Key: frei = Exempt]

Exemption from the road-use ban pursuant to Section 40(1) of the Federal Emissions Protection Act

shall apply to motor vehicles which

a) are exceptionally permitted under Section 1(2) of the Order on the marking of low-pollution motor vehicles of ... [to be inserted: date of and source for the said Order],

b) are provided with a sticker of the colour indicated on the supplementary sign pursuant to Section 3(1) of the Order on the marking of low-pollution motor vehicles of ... [to be inserted: date of and source for the said Order], or which,

c) in pursuance of Annex 3 (re Section 2(3)) of the Order on the marking of low-pollution motor vehicles of ... [to be inserted: date of and source for the said Order], are not subject to marking by means of stickers."

Article 3

Entry into force

This Order shall enter into force on [to be inserted: date of the first day of the fifth calendar month following promulgation].

The *Bundesrat* has given its approval.

**Explanatory Statement**

A. General

Pursuant to Section 4(2) of the 22nd Federal Emissions Protection Order, it has been a requirement to comply with stringent emission limit values for fine particulate matter since 1 January 2005. Even if fine particulate matter emissions in Germany have clearly fallen in the past and continue to do so, nonetheless further cases of exceeding the limit values must be anticipated.

Section 40(3) of the Federal Emissions Protection Act empowers the Federal German Government, with the consent of the *Bundesrat*, to prescribe, by means of an order, that low-pollution motor vehicles that have been or could be partially or entirely exempted from road-use bans [sic], together with the defining criteria for this and the official marking of the motor vehicles. Accordingly, marked vehicles may, depending on the local rules, be partially or entirely exempted from road-use restrictions or bans.

In a resolution on 27 May 2005, the *Bundesrat* invited the Federal German Government to lay down a Marking Order in pursuance of Section 40(3) of the Federal Emissions Protection Act (German reference: BR-Drs. 144/05 (Beschluss)).

The aim of such a Marking Order is to regulate the marking of vehicles according to their emissions of pollutants in a uniform way across Germany. The issuing of road-use restrictions or bans – on the basis of the marking of vehicles as regulated under the Order in question – lies within the sphere of competence of the *Länder*. This marking is effected by means of stickers.

Marking applies to motor vehicles of categories M and N in pursuance of Annex II A points 1 and 2 of Council Directive 70/156/EEC. Motor vehicles are subdivided into four pollutant classes according to their emissions of pollutants and marked using coloured stickers bearing the number of the pollutant class. Pollutant classes 2 to 4 are based on the particle limit values of Euroclasses 2 to 4 (passenger vehicles) and II to V (goods vehicles). Euro IV and Euro V goods vehicles and EEV vehicles are assigned to pollutant class 4. The colour of the stickers is as follows: red for pollutant

class 2, yellow for pollutant class 3 and green for pollutant class 4. Vehicles which cannot be classified into pollutant classes 2 to 4 do not receive a sticker.

Vehicles with compression-ignition engines (diesel engines) since Euro 1 are assigned to the next pollutant class up, on request, if, by means of fitting with technology to reduce particle emissions, they meet the particle limit value for the next pollutant class up. Appropriate technology to reduce particle emissions is already available on the market for many vehicles.

Differentiation according to pollutant classes allows the competent authorities to put in place locally and regionally tailored measures in order to restrict road use. Basing the rules on the EU limit value classes also ensures a clear policy of equal treatment for vehicles from EU Member States.

There are associated costs, in respect of the erecting of road signs, for the national budget and for those of the Länder and the municipalities where measures are implemented to restrict road use, such costs to be managed as part of the responsibility for the building, maintenance and improvement of public thoroughfares. Since it cannot at present be foreseen in how many cases road signs declaring measures under traffic law will be erected on the basis of the revised regulations, the costs cannot currently be quantified. These are, however, met from the budgetary items for road construction of the relevant party responsible for the building, maintenance and improvement of public thoroughfares without the appropriations for the item in question having to be raised. The Order does not does not give rise to any tasks associated with enforcement costs at Federal, *Land* or municipality level.

There are at worst small additional costs for both private motor vehicle owners and for business, in particular for medium-sized enterprises, in relation to the issuing of the stickers since stickers are only issued on application.

The Order is not expected to have a significant impact on individual prices or the general price index, in particular the retail price index. Public budgets will not be so heavily burdened by the regulation that there will be any direct effects on prices resulting from this.

The Order has no relevance in terms of equality policy since it is not anticipated that the Order will have any differing direct or indirect effects on men and women.

**Regarding the individual provisions**

Re Article 1 ([...] Order enacting the Federal Emissions Protection Act)

Re Section 1 (Area of application)

Subsection (1) of this provision specifies the area of application of the Order.

Subsection (2) governs exemptions from road-use bans pursuant to Section 40(1) of the Federal Emissions Protection Act.

The application of this Order in the implementation of road-use restrictions and bans in order to reduce fine particulate pollution lies within the sphere of competence of the *Länder* within the scope of individual measures pursuant to Section 40(1) Federal Emissions Protection Act. For such purposes, the road traffic authorities make use of the road signs and traffic management equipment prescribed under road traffic regulations in accordance with the Road Traffic Order.

Subsection (2) implements the granting of power under Section 40(3) sentence 2 of the Federal Emissions Protection Act and authorises further measures in individual cases. In order to be able to react suitably to unforeseeable cases of hardship, it must be possible to grant further exemptions from road-use bans pursuant to Section 40(1) of the Federal Emissions Protection Act, insofar as the use of motor vehicles is urgently required in the public interest or in the overriding privates interests, in particular for the protection of production processes or for the supply of the population with essential goods and services. The police are to have decision-making powers in conceivable unforeseen urgent cases, so that it is possible to master the situation.

Re Section 2 (Classification of motor vehicles into pollutant classes)

This provision governs the possibility of appropriately marked vehicles being exempted from a road-use ban and the allocation of motor vehicles to their pollutant classes.

Marking applies to motor vehicles of categories M and N in pursuance of Annex II A points 1 and 2 of Directive 70/156/EEC. Motor vehicles are categorised into four pollutant classes. The details of classification into the pollutant classes 2 to 4 can be found in Annex 2.

The following vehicles are categorised in pollutant class 1 and thus are not marked with a sticker:

1. old motor vehicles powered by compression-ignition engines (diesel engines) prior to Euro 1; these exhibit particularly high nitrogen oxide and particle emissions;

2. Euro 1 motor vehicles powered by compression-ignition engines not fitted with a particulate matter reduction system;

3. motor vehicles powered by positive-ignition engines (Otto engines) not in compliance with the guidelines specified in Annex 2.

Re Section 3 (Marking)

This provision regulates the type and nature of the stickers and the manner in which they are affixed. In order to be able to distinguish, easily and clearly, between pollutant classes, the sticker shall bear the number of the pollutant class.

The stickers must be of such a nature that they are non-fading and that they cannot be re-used or forged. Stickers must further be so designed and affixed that they self-destruct on removal from the windscreen.

Re Section 4 (Issuing of the stickers)

This provision regulates the issuing of stickers. In addition to the approval bodies and the competent authorities under *Länder* law, it is also intended for the bodies accredited for the performance of the exhaust-gas examination (such as technical inspection agencies and workshops) to be able to issue the stickers. The same applies to the issuing of stickers for foreign motor vehicles.

Re Section 5 (Documentary proof of pollutant class for vehicles authorised in Germany)

The classification of motor vehicles into the pollutant classes takes place on the basis of the emissions code numbers stated in the vehicle documentation. In the case of vehicles subject to regulation under the toll rules, classification may take place in accordance with the categorisation undertaken under such rules.

In order to facilitate the classification of motor vehicles into pollutant classes and thus the issuing of stickers, the Federal Ministry of Transport, Building and Urban Development will publish a summary of the emissions-based code numbers for the pollutant classes in the Transport Gazette.

Re Section 6 (Documentary proof of pollutant class for vehicles authorised abroad)

In order for it also to be possible to issue stickers for foreign vehicles, regulations should also be provided for such vehicles. Thus, the documentary proofs provided for under Sections 8 and 9 of the Goods Vehicle Toll Order may be submitted in order to enable classification of vehicles subject to regulation under the toll rules into a pollutant class. In the case of vehicles for which it is not possible to provide documentary proof of compliance with a particular exhaust-gas directive, it is assumed that the vehicles complied with the then applying EC exhaust-gas directive on the day of first approval for road use. The directive thus indicated is decisive for allocation into the relevant pollutant class.

Re Annex 1 (Sticker design)

Annex 1 regulates the design, colour and size of and script on the stickers envisaged for the marking of motor vehicles.

Re Annex 2 (Classification of motor vehicles into the pollutant classes)

Annex 2 regulates the classification of motor vehicles into the pollutant classes. The regulations govern motor vehicles of vehicle categories M and N pursuant to Annex II A to Council Directive 70/156/EEC of 6 February 1970. Motor vehicles are allocated into pollutant classes 2 to 5 in accordance with the relevant EC exhaust-gas directives and the requirements pertaining to retrofitting with a particulate matter reduction system as laid down (Annex XXVI) or to be laid down (Annex XIV) in the Road Traffic Approval Order.

Re subsection (1)

Re point 1. (Pollutant class 1)

Category Euro 1 and worse motor vehicles powered by compression-ignition engines (diesel engines) and motor vehicles powered by positive-ignition engines (Otto engines) which do not meet the requirements of category Euro 1 (Directive 91/441/EEC or better) are assigned to pollutant class 1.

Re point 2. (Pollutant class 2)

Category M and N motor vehicles powered by compression-ignition engines are assigned to pollutant class 2 if they fall within the scope of Directive 70/220/EEC or Directive 88/77/EEC and comply with the requirements laid down for exhaust-gas class Euro 2/Euro II in the relevant EC directives. Categorisation into this class may also be attained on the basis of the retrofitting of vehicles which are currently worse-classified in terms of their emissions characteristics. The requirements pertaining to retrofitting have been laid down in the Road Traffic Approval Order (amended version currently in the course of preparation) – in Annex XXVI (29th Order amending the Road Traffic Approval Order of 27 January 2006 (Federal Law Gazette I p. 287)) or Annex XIV in the case of goods vehicles. [Category PM 0] of Annex XXVI (amendment of Annex XXVI currently in the course of preparation) and the particulate matter reduction class [PMK 0] of Annex XIV are to be assigned to pollutant class 2.

Re point 3. (Pollutant class 3)

Category M and N motor vehicles powered by compression-ignition engines are assigned to pollutant class 3 if they fall within the scope of Directive 70/220/EEC or Directive 88/77/EEC and comply with the requirements laid down for exhaust-gas class Euro 3/Euro III in the relevant EC directives. Categorisation into this class may also be attained on the basis of the retrofitting of vehicles which are currently worse-classified in terms of their emissions characteristics. The requirements pertaining to retrofitting have been laid down in the Road Traffic Approval Order – in Annex XXVI (29th Order amending the Road Traffic Approval Order of 27 January 2006 (Federal Law Gazette I p. 287)) or Annex XIV in the case of goods vehicles. Particulate matter reduction category PM 1 of Annex XXVI and the particulate matter reduction class [PMK 1] of Annex XIV (amended version currently in the course of preparation) are to be assigned to pollutant class 3.

Re point 4. (Pollutant class 4)

Category M and N motor vehicles powered by compression-ignition engines are assigned to pollutant class 4 if they fall within the scope of Directive 70/220/EEC or Directive 88/77/EEC and comply with the requirements laid down for exhaust-gas class Euro 4/Euro IV, V or EEV in the relevant EC directives. Categorisation into this class may also be attained on the basis of the retrofitting of vehicles which are currently worse-classified in terms of their emissions characteristics. The requirements pertaining to retrofitting have been laid down in the Road Traffic Approval Order – in Annex XXVI (29th Order amending the Road Traffic Approval Order of 27 January 2006 (Federal Law Gazette I p. 287)). Also classified in pollutant class 4 are motor vehicles with compression-ignition engines of categories $M_1$ and $N_1$ (passenger vehicles and light goods vehicles) if they comply with the particle limit value of 5.0 mg/km proposed by the Commission for tax relief and for the Directive Euro 5 (Council document 5163/06 of 10 January 2006).

Re subsection (2)

Motor vehicles powered by positive-ignition engines (Otto engines) are also assigned to pollutant class 4 if they meet the requirements set out in subsection (2) of Annex 2.

Re subsection (3)

Motor vehicles powered by means other than combustion engines (such as electric engines or vehicles powered by fuel cells) shall also be assigned to pollutant class 4.

Re Annex 3 (Exemptions from the marking obligation pursuant to Section 2(1))

Mobile machines and equipment, agricultural and forestry tractors and work vehicles are exempt from road-use bans as the amount of emissions they output on urban roads is small. Two and three-wheeled motor vehicles are also exempted from road-use bans. There are around 5.5 million motorcycles; of these, around 5500 have diesel engines. As a result of the low proportion of the total annual road usage which they represent, these vehicles make only a comparatively small contribution to particle emissions.

Moreover, vehicles used for certain purposes (medical care, transport of the disabled, police, fire brigade, military, etc.) are excepted. Vehicles of this nature do not require marking.

Re Article 2 (Amendment to the Road Traffic Order)

Re point 01:

Section 39(2) sentence 3 is being amended by means of the insertion of the words “unless specified otherwise”. It is intended for it to be possible for marked motor vehicles to be entirely or partially exempted from road-use bans. The supplementary sign “Exemption from the road-use ban pursuant to Section 40(1) of the Federal Emissions Protection Act” is being introduced for this purpose. The depiction of the stickers on supplementary signs in colour is contrary to the general regulation of Section 39(2) sentence 3 of the Road Traffic Order, according to which images on supplementary signs are to be in black. It is for this reason that the general regulation of Section 39(2) sentence 3 of the Road Traffic Order is being adapted.

Re point 1:

If the competent road traffic authorities put in place road-use bans on the basis of Section 40(1) of the Federal Emissions Protection Act in conjunction with the [...] Order enacting the Federal Emissions Protection Act because this is envisaged under a clean air plan or action plan pursuant to Section 47(1) or (2) of the Federal Emissions Protection Act it is necessary for such road-use bans to be able to be implemented by means of road signs. It is for this reason that a special road sign has been introduced for the purpose. Since sign 270.1 serves to delimit the area in question, the sign shall be displayed at every access road to the area. Sign 270.2 is to be used to mark the end of the ban zone.

It is intended for it to be possible for low-pollution, marked motor vehicles to be entirely or partially exempted from such road-use bans. The supplementary sign “Exemption from the road-use ban pursuant to Section 40(1) of the Federal Emissions Protection Act” is being introduced for this purpose. All the stickers of exempted vehicles are to be displayed on the supplementary signs in the appropriate colours.

The supplementary sign exempts from the road-use ban all motor vehicles marked in accordance with Section 3(1) of the Order on the marking of low-pollution vehicles provided and to the extent that motor vehicles subject to a marking requirement are also marked with the sticker depicted on the supplementary sign.

The image depicted on the supplementary sign is only an example; it is also permissible for fewer stickers to be depicted. The size of the stickers depicted shall be based on their perceptibility and legibility (cf. point 1.3 of Part 1 of the Catalogue of Road Signs 1992).

The supplementary sign additionally exempts all vehicles which are not subject to marking, in pursuance of Annex 3 (re Section 2(3)) of the Order on the marking of low-pollution motor vehicles. The behaviour of road users is primarily governed by road traffic law. It is to be assumed that those drivers affected in this respect are able to substantiate the existence of this “exception” under the law in the course of traffic monitoring.

The supplementary sign also exempts all motor vehicles which, in pursuance of Section 1(3) of the Order on the marking of low-pollution vehicles, are either unmarked or categorised into a pollutant class which is too low for access, but which, in the public interest, are exceptionally approved in pursuance of Section 40(3) sentence 2 of the Federal Emissions Protection Act [as exceptions] from the road-use ban pursuant to Section 40(1) of the Federal Emissions Protection Act. Insofar as this approval is granted by the competent authorities and not by the police, it shall, as a rule, be possible to substantiate the exceptional approval in order to facilitate traffic monitoring; this can practically be done by means of a written or electronic approval. The *Länder* determine the competent authority. It may, in contrast, be left open whether, in addition hereto, only the road traffic authorities may issue exception authorisations on the basis of Section 46(1) sentence 1 point 11 of the Road Traffic Order (Exceptions from the ban described on the sign 270.1). Clarification of this issue may be left to be settled at the level of the competent Federation/*Länder* Technical Committees.

Re Article 3 (Entry into force)

This provision regulates the entry into force of the Order. A certain amount of time is required to acquire the stickers and make preparations for their issuing. The approval authorities also need that

period in order to adapt or amend their programmes accordingly (inclusion of the code lists) and to train their staff.

The envisaged transitional period takes account of this requirement.

**First Order**

**Amending the Thirty-Fifth Order implementing the Federal Immission Control Act (Order on the Marking of Low Pollution Motor Vehicles)**[*]

of

… … 2007

The following is decreed

– by the Federal Government, after hearing the parties concerned, on the basis of Section 40 (3) of the Federal Immission Control Act in the version promulgated on 26 September 2002 (Federal Law Gazette I p. 3830), as most recently amended by Article 3 of the Act of 18 December 2006 (Federal Law Gazette I p. 3180), and

– by the German Ministry of Transport, Building and Urban Affairs and by the German Ministry of the Environment, Nature Conservation and Nuclear Safety on the basis of Section 6 (1) (3) (d) and Section 6 (1) (5a), each in conjunction with Section 6 (2a) of the Road Traffic Act in the version promulgated on 5 March 2003 (Federal Law Gazette I p. 310), as most recently amended by Article 2 (4) of the Act of 14 August 2006 (Federal Law Gazette I p. 1958):

**Article 1**

The Thirty-Fifth Order implementing the Federal Immission Control Act (Order on the marking of low pollution motor vehicles) of 10 October 2006 (Federal Law Gazette I p. 2218), is amended as follows:

I. Section 1 (2) is worded as follows:

"The competent authority, and in undeferrable cases the police, may permit the road use of vehicles covered by road-use bans within the meaning of Section 40 (1) of the Federal Immission Control Act to and from particular facilities where this is in the public interest, in particular where it is necessary for the supply of the population with essential goods and services or where overriding and undeferrable interests of individuals so require, in particular where manufacturing and production processes could not otherwise be maintained."

II. Section 6 is amended as follows:

1. Paragraph (3) is amended as follows:

a) In number 2, the following letter c) is added after letter b):

"c) if they were registered for the first time after 1 January 1993 and meet the requirements stated in Annex 2 (1) (2) (g) and (h) or are equivalent thereto and this is substantiated by documentation,"

b) In number 3, the following letter c) is added after letter b):

[*] The obligations arising from Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations and information society services (OJ L 204 p. 37), amended by Directive 98/48/EC of the European Parliament and of the Council of 20 July 1998 (OJ L 217 p. 18), have been met.

“c) if they were registered for the first time after 1 October 1996 and meet the requirements stated in Annex 2 (1) (3) (j) to (l) or are equivalent thereto and this is substantiated by documentation,”

c) In number 4, after letter c) the full-stop is replaced by a comma and the following letters d) and e) are added thereafter:

“d) if they were registered for the first time after 1 October 2000 and meet the requirements stated in Annex 2 (1) (4) (q) and (r) or are equivalent thereto and this is substantiated by documentation,

e) if they fall within the scope of Directive 70/220/EEC or Directive 2005/55/EC of the European Parliament and of the Council of 28 September 2005 on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles (OJ L 275 p. 1) in the most recently amended version as published in the Official Journal of the EU.”

2. Paragraph (4) is worded as follows:

“(4) Motor vehicles with positive-ignition engines of categories M and N shall be classified in pollutant class 4 if:

1. they fall within the scope of Directive 70/220/EEC and were first registered after 31 December 1992,

2. they fall within the scope of Directive 88/77/EEC as amended by Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles and amending Council Directive 88/77/EEC (OJ L 44 p. 1, 16 February 2000), comply with the stipulations of this Directive and, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) or B 1 (2005) or B 2 (2008) or under C (EEV) of Tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive and provide documentation to substantiate compliance with the emission limits, or

3. they fall within the scope of Directive 88/77/EEC as amended by Directive 2001/27/EC of the European Parliament and of the Council of 10 April 2001 adapting to technical progress Council Directive 88/77/EEC on the approximation of the laws of the Member States on measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles (OJ L 107 p. 10), comply with the stipulations of this Directive and, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) or B 1 (2005) or B 2 (2008) or under C (EEV) of Tables 1 and 2 contained in point 6.2.1 of Annex I to Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1, 16 February 2000) and documentation is provided to substantiate compliance with the emission limits.”

3. The following paragraph (5) is inserted after paragraph (4):

“(5) Motor vehicles with positive-ignition engines of categories M and N shall be classified in pollutant class 4 if:

1. documentation is provided to substantiate the fact that the vehicle has reduced emissions meeting the requirements of Annex XXIII to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), or is equivalent thereto, or

2. documentation is provided to substantiate the fact that the vehicle has reduced emissions as a result of retrofitting with an exhaust gas purification system complying with the provisions of the 52nd Order on Exemptions from the Road Traffic Registration Order of 13 August 1996 (Federal Law Gazette I p. 1319), as most recently amended by Article 1 of the Order of 18 February 1998 (Federal Law Gazette I p. 390), or is equivalent thereto, or

3. they fall within the scope of Directive 70/220/EEC or Directive 2005/55/EC in the most recently amended version as published in the Official Journal of the EU."

III. Annex 2 (1) is amended as follows:

1. In number 2, after letter f) the full-stop is replaced by "or" and the following letters are added thereafter:

"g) by means of their fitting with a particulate matter reduction system, meet the requirements of 2.1.1 and 2.1.2 of Annex XXVI to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), or

h) by means of their fitting with a particulate matter reduction system, meet the requirements of 3.4.1 and 3.4.2 of Annex XIV to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893)."

2. In number 3 (i) the full-stop is replaced by "or" and the following letters are added thereafter:

"j) by means of their fitting with a particulate matter reduction system, meet the requirements of 2.1.2 of Annex XXVI to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), with the exception of category M vehicles with no more than six seats including the driver's seat or with a maximum mass not exceeding 2500 kg, or

k) by means of their fitting with a particulate matter reduction system, meet the requirements of 3.4.2 (2) of Annex XIV to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), with the exception of category $N_1$ vehicles with a reference mass not exceeding 1250 kg (group I), or

l) by means of their fitting with a particulate matter reduction system, meet the requirements of 3.4.3 of Annex XIV to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893)."

3. In number 4 (p) the full-stop is replaced by "or" and the following letters are added thereafter:

"q) by means of their fitting with a particulate matter reduction system, meet the requirements of 3.4.3 (2) of Annex XIV to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), with the exception of category $N_1$ vehicles with a reference mass not exceeding 1250 kg (group I), or

r) by means of their fitting with a particulate matter reduction system, meet the requirements of 3.4.4, 3.4.5 or 3.4.6 of Annex XIV to the Road Traffic Registration Order in the version promulgated on 28 September 1998 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), or

s) fall within the scope of Directive 70/220/EEC or Directive 2005/55/EC in the most recently amended version as published in the Official Journal of the EU."

IV. Annex 2 (2) is amended as follows:

1. The introductory sentence is worded as follows:

"Motor vehicles with positive-ignition engines of categories M and N pursuant to Annex II A points 1 and 2 of Council Directive 70/156/EEC shall be assigned to pollutant classes 1 and 4 as follows:

1. Pollutant class 1

motor vehicles which do not fall under pollutant class 4

2. Pollutant class 4

Motor vehicles which"

2. After letter k) the full-stop is replaced by "or" and the following letters are added thereafter:

"l) fall within the scope of Directive 88/77/EEC as amended by Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1, 16 February 2000), comply with the stipulations of this Directive and, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) or B 1 (2005) or B 2 (2008) or under C (EEV) of Tables 1 and 2 contained in point 6.2.1 of Annex I to the Directive, or which

m) fall within the scope of Directive 88/77/EEC as amended by Directive 2001/27/EC of the European Parliament and of the Council of 10 April 2001 (OJ L 107 p. 10), comply with the stipulations of this Directive and, in their emissions of gaseous pollutants and particulate air pollutants, do not exceed the limit values given under A (2000) or B 1 (2005) or B 2 (2008) in Tables 1 and 2 contained in point 6.2.1 of Annex I to Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 (OJ L 44 p. 1, 16 February 2000), or which

n) meet the requirements of Annex XXIII to the Road Traffic Registration Order in the version promulgated on 28 September 1988 (Federal Law Gazette I p. 1793), as most recently amended by Article 1 of the Order of 24 May 2007 (Federal Law Gazette I p. 893), or

o) have been retrofitted in accordance with the provisions of the 52nd Order on Exemptions from the Road Traffic Registration Order of 13 August 1996 (Federal Law Gazette I p. 1319), as most recently amended by Article 1 of the Order of 18 February 1998 (Federal Law Gazette I p. 390), or

p) fall within the scope of Directive 70/220/EEC or Directive 2005/55/EC in the most recently amended version as published in the Official Journal of the EU."

V. Annex 3 number 5 is worded as follows:

"5. ambulances, doctors' vehicles bearing the appropriate marking "doctor on call" (in accordance with Section 52 (6) of the Road Traffic Registration Order),"

**Article 2**

Entry into force

This Order shall enter into force on (to be inserted: date of the day following promulgation).

The *Bundesrat* has given its approval.

Berlin, dated

The Federal Chancellor

The Federal Minister for the Environment, Nature Conservation and Nuclear Safety

The Federal Minister for Transport, Building and Urban Affairs

**Explanatory statement**

A. General

This order re-introduces the provisional rulings on the retrofitting of used vehicles with particulate filters contained in the Government's draft 35th Federal Immission Control Order, which had been deleted on the basis of the vote by the *Bundesrat* on 4 April 2006 (parliamentary papers. 162/06) on account of the fact that the Road Traffic Registration Order had not yet been appropriately amended. At the request of the *Länder*, at the same time pollutant class 4 from the 35th Federal Immission Control Order is being expanded to include vehicles with a catalytic converter as described in Annex XXIII to the Road Traffic Registration Order as well as vehicles retrofitted with a catalytic converter as described in the 52nd Order on Exemptions from the Road Traffic Registration Order.

On the basis of this amendment, under Section 1 (2) of the Order on Marking vehicles covered by road-use bans under Section 40 (1) of the Federal Immission Control Act may also be permitted to be used on the roads in environmental zones, subject to certain conditions. The competent authority, and in undeferrable cases the police, may permit the road use of such vehicles provided this is reasonable taking into consideration the local circumstances, in particular the type and extent of local pollution.

In addition to the public interest, significant and undeferrable individual interests may justify exemption from bans on road use. This ruling in current law is designed to avoid particular hardship that might be associated with a ban on road use without jeopardising compliance with the EU immission limit values. Individual and public interests are to be weighed up against each other.

Concerning the matter of whether and to what extent exemptions from road-use bans are reasonable in view of the specified immission limit values or are required in view of hardships that would otherwise be imposed on the persons concerned, the decision is to be made based on local circumstances. Both the type and extent of the local air pollution as well as meteorological aspects are to be taken into consideration here.

Decisions by the competent authorities are possible without excessive administrative expense. Under Section 1 (2) all types of action under general administrative law can be used by the competent authority. If the matter concerns particular groups, e.g. residents, exhibitors, tradesmen or the keepers of vintage vehicles, instead of individual administrative acts it is appropriate to pass a general order exempting the group of individuals in question from road-use bans. General orders within the aforementioned meaning are based on Section 1 (2) – i.e. on immission control law in conjunction with Section 35 clause 2 of the Administrative Orders Act. In other words, the general order under immission control law does not have to be implemented by a traffic sign, since the "principle of visibility" of road traffic law does not apply in immission control law.

No additional costs arise for budgets at Federal, *Land* or municipality level. The Order does not does not give rise to any tasks associated with enforcement costs at Federal, *Land* or municipality level. There are at worst small additional costs for both private motor vehicle owners and for business, in particular for medium-sized enterprises, in relation to the issuing of the stickers since stickers are only issued on application.

The Order is not expected to have a significant impact on individual prices or the general price index, in particular the retail price index.

For estimating the bureaucratic costs according to the standard costs model (SCM) the following is to be established:

The Order on Marking (35th Federal Immission Control Order) of 16 October 2006, effective from 1 March 2007, introduces the possibility of classifying vehicles according to pollutant emissions using stickers. At the same time, an amendment to the Road Traffic Order creates opportunity to establish zonal road-use bans using the new traffic signs 270.1 and 270.2 as described in Section 41 (2) No. 6 of the Road Traffic Order. Exemption from the ban on road use in a zone marked as having a road-use ban in accordance with Section 40 (1) of the Federal Immission Control Act may be permitted by a supplementary sign for sign 270.1. This supplementary sign shows certain stickers which exempt

vehicles bearing such a sticker from the road-use ban. The keeper of the vehicle therefore only has to place such a sticker on his vehicle if he wants exemption from the road-use ban in an environmental zone.

Around 42 million of the approximately 50 million vehicles registered in Germany are affected by the Order on Marking of 16 October 2006, provided the keepers of the vehicles decide to acquire a sticker. No data is available for the number of foreign vehicles affected. Around 2 million extra domestic vehicles and an unknown number of foreign vehicles will additionally be affected as a result of the imminent amendment to the Order on Marking. The costs of acquiring the sticker are in the order of EUR 5 – 10.

This expansion of the group of vehicles entitled to a sticker also expands two information obligations for business, citizens and the administration. The expanded information obligations result from Section 6 of the Order on Marking for foreign vehicles and from Sections 3 and 4 of the Order on Marking for domestic vehicles.

It is estimated that in total around 1.6 million vehicles belonging to domestic keepers and approximately 160,000 foreign vehicle keepers will obtain a sticker and be affected by the expansion of information obligations due to the amendment of the Order on Marking. It is to be assumed that in the initial period following the entry into force of the Order (1st phase of procurement) an estimated 40% of domestic and foreign vehicle keepers will acquire stickers, since it is not yet known where any road-use ban zones will be established; that is, an estimated approximately 640,000 domestic and approximately 64,000 foreign vehicle keepers will acquire a sticker. In the 2nd phase (after road-use bans have been established) the number of stickers procured will increase such that an estimated approximately 960,000 domestic and approximately 96,000 foreign vehicle keepers will obtain a sticker. In the subsequent years from 2009, it is estimated that stickers will be obtained for 80% of all newly registered domestic vehicles (approximately 3 – 3.5 million per year). In addition, there is replacement procurement for damaged stickers (e.g. if a windscreen gets broken). It is estimated that stickers will be obtained for around 200,000 domestic vehicles and an estimated approximately 20,000 foreign vehicles as a result of the expanded information obligation due to the amendment of the Order on Marking.

The subdivision of domestic vehicles affected by the Order on Marking into commercial, private and public vehicle keepers is based on the data for new vehicle registrations in Germany, which has been projected accordingly. Since these figures are not available for foreign registrations, they will be transferred analogously to find estimates. Accordingly, around 1 million of the approximately 2 million registered domestic vehicles that are now affected by the expansion of the Order on Marking are classified as commercial vehicles. Approximately 100,000 of foreign registered vehicles are estimated to be commercial vehicles. It is estimated that around 800,000 domestic vehicle keepers and around 80,000 foreign vehicle keepers will make use of the opportunity to acquire a sticker. In the 1st phase it is estimated that around 320,000 domestic vehicle keepers and around 32,000 foreign vehicle keepers will acquire stickers. In the 2nd phase it is estimated that 480,000 domestic vehicle keepers and 48,000 foreign vehicle keepers will acquire stickers. In each of the subsequent years it is estimated that 100,000 stickers will be obtained for domestic commercial vehicles, for new vehicles and for replacements for damaged stickers, and that around 10,000 stickers will be obtained by foreign commercial vehicles.

The Order on Marking provides for the minimum possible expense for both information obligations. Existing arrangements can be used, dispensing entirely with the need for a special form (e.g. for processing applications). For the issue of the stickers, Section 4 of the Order on Marking foresees the simplest possible solution. The issuing points are all the registration centres as well as those garages that have been approved to carry out exhaust emissions analyses in accordance with Section 47a (2) of the Road Traffic Registration Order. Keepers of vehicles within Germany will receive the sticker on presentation of their vehicle registration document. No other documentation is required. In the case of foreign vehicles, according to Section 6 of the Order on Marking these will be classified in a pollutant class via the date of registration of the vehicle or by means of certificates pursuant to Sections 8 and 9 of the Goods Vehicle Toll Order of 24 June 2003. Again, the foreign vehicle keeper merely has to produce his vehicle documents if he wishes to acquire a sticker.

The time taken up by the acquisition of a sticker is kept as short as possible, since the sticker can be obtained when the vehicle is due to visit the garage anyway. It is therefore estimated that it will take around 2 minutes for domestic vehicle keepers (1 minute to present the vehicle registration document and 1 minute to affix the sticker) and 10 minutes for foreign vehicle keepers to obtain a sticker.

Since all sectors of the economy are equally affected by this regulation and the level of qualification for obtaining a sticker is deemed low, on the basis of the table of tariffs from the Federal Statistical Office for ex-ante estimates, 2003 edition (WZ 2003) the sum of EUR 19.30 per hour has been used as a basis for the average financial cost of obtaining a sticker. This results in total bureaucratic costs for

The German economy of around EUR 1,030,000 in total

[*2 min. x €19.30/60 min. x 1,600,000 stickers*] and

the foreign economy of around EUR 515,000 in total

[*10 min. x €19.30/60 min. x 160,000 stickers*].

Based on this calculation, the 1st phase of the procurement of the stickers will result in bureaucratic costs for the German economy of around EUR 412,000 and for the foreign economy of around EUR 206,000. In the 2nd phase of the procurement the bureaucratic costs for the German economy are estimated at around EUR 618,000 and for the foreign economy at around EUR 209,000. In the subsequent years (from 2009) these will be around EUR 129,000 for the German economy and around EUR 65,000 for the foreign economy.

There are no more expedient, more economic regulatory alternatives to the present Order. Possible alternatives might include setting up issuing centres at the authorities and/or a formal application process. These alternatives would clearly be associated with higher bureaucratic and other costs. In addition, it must be taken into consideration that without the current expansion of the group of vehicles entitled to a sticker it would not be possible to exempt the group concerned from the ban on road use in a zone marked as having a road-use ban in accordance with Section 40 (1) of the Federal Immission Control Act.

The Order has no relevance in terms of equality policy since it is not anticipated that the Order will have any differing direct or indirect effects on men and women.

B. Regarding the individual provisions

Re Article 1

The intended amendments serve to transpose the improvements arising from the Thirtieth Order Amending the Road Traffic Registration Order when retrofitting used vehicles as well as Euro 1 diesel cars with particulate reduction systems to the 35th Federal Immission Control Act and to allocate vehicles to the pollutant groups in Annex 2 to the Order. This in particular makes it attractive to retrofit trucks and buses, which is where there is greatest potential for reducing particulates. According to investigations by the Federal Environment Agency, over 60% of particulate emissions are due to urban exhaust emissions from trucks and buses.

In addition, certain vehicles with a positive-ignition engine which until now have not been able to obtain a sticker are equated with Euro 1 vehicles. These are vehicles covered by Annex XXIII to the Road Traffic Registration Order, the vehicle documents of which are marked with the emissions-based codes “01” and “02”. Similarly, vehicles retrofitted with a catalytic converted in accordance with the provisions of the 52nd Order on Exemptions from the Road Traffic Registration Order of 13 August 1996, the vehicle documents of which are marked “LOW EMISSIONS E2/RETROF.:” with the emissions-based code “77” are classified in this pollutant class. This classification is justified since the emissions behaviour (in particular nitrogen oxide) of the vehicles not previously included is essentially equivalent to that of Euro 1 vehicles. Other older vehicles with a catalytic converter which do not meet the requirements of Annex XXIII or of the 52nd Order on Exemptions from the Road Traffic Registration Order are not taken into consideration in sticker marking. Thus Annexes XXIV and XXV to the Road Traffic Registration Order, for example, have weaker limit value requirements and have no provisions regarding durability as prescribed in Annex XXIII to the Road Traffic Registration Order. In addition, Annex XXIII requires the installation of an evaporation filter for hydrocarbon emissions.

Annex 2 (2) “Motor vehicles with positive-ignition engines…”, which lists only vehicles from the area of application of Directive 70/220/EEC, is supplemented by the inclusion of vehicles falling within the scope of Directive 88/77/EEC (used vehicles) with positive-ignition engines powered by natural gas or liquefied petroleum gas.

Re Article 1, I.

The amendment in Section 1 (2) means that rulings on exemption are not fundamentally excluded for vehicles already having a sticker that are marked with a sticker below the required class.

Re Article 1, II. No 1 to No 3

With the inclusion of regulations in the 35th Federal Immission Control Act on the retrofitting of used vehicles and of Euro 1 diesel cars with particulate reduction systems as well as the classification of vehicles with a catalytic converter in accordance with Annex XXIII and the 52nd Order on Exemptions from the Road Traffic Registration Order into a pollutant class with a sticker mark and the inclusion of used vehicles with positive-ignition engines fuelled by natural gas or liquefied petroleum gas, for equal treatment of vehicles registered abroad it is necessary to provide an equivalent adjustment for these. The regulations stated can achieve this. Proof may be provided by documentary evidence, for example in the form of a manufacturer's certificate, a certificate of installation or an addendum to this effect in the vehicle documents.

Re Article 1, III.

These provisions transpose regulations on the retrofitting of used vehicles and Euro 1 diesel cars from the Thirtieth Order Amending the Road Traffic Registration Order and classify the pollutant classes in Annex 2 to the 35th Federal Immission Control Order. This means that where the emissions behaviour of the vehicles is improved subsequently, the intended advantages to the user resulting from a better classification in a pollutant class in the 35th Federal Immission Control Order can be granted.

Re Article 1, IV. No 1 and No 2

This regulation means that, in addition to vehicles with positive-ignition engines as described in Directive 70/220/EEC, vehicles with positive-ignition engines fuelled by natural gas or liquefied petroleum gas which fall under Directive 88/77/EEC can also be included in the sticker marking in future.

Re Article 1, V.

The amendment in Annex 3 is there for clarification purposes and to avoid possible abuses.

Re Article 2

This provision regulates entry into force.

## 20. Annex 7. Air quality impacts details

This annex presents the air quality impact assessments that are available for LEZs around Europe. There is a wide range of information, undertaken at different times which has been summarised in and Table 4. The vehicle fleet composition and the compliance data are presented in section 4.5.2. Some of them are using the 'new' emissions factors from 2009/10 (that particularly affect NOx, see section 6.3), others older emissions factors.

### 20.1. Germany

In Germany the national emissions factors are used for modelling according to which Euro 4 diesel cars $NO_x$ emissions in city driving are 10 times that of petrol. It should be noted that the economic downturn and the scrappage scheme has also impacted on traffic flow and vehicle renewal. There is more detail included for assessments completed before February 2010, with summaries for the more recently published reports from London, Berlin and the Rhur area of Germany given here and in section 6.

A report for the German Environment Agency (UBA) estimated the impact on $PM_{10}$ exceedences as in the following table.

**Table 10. Estimated LEZ impact on $PM_{10}$ daily exceedences**

| | 2007 | | 2010 | |
|---|---|---|---|---|
| | **Berlin** | **Kassel** | **Berlin** | **Kassel** |
| **Diesel Euro 2(PM), petrol Euro 1** | -5* | -3 | -5 | -3 |
| **Diesel Euro 3(PM), petrol Euro 1** | -8 | -5 | -8 | -5 |
| **Diesel Euro 4(PM), petrol Euro 1** | -20 | -12 | -18 | -11 |

* confirms with monitored data

#### 20.1.1. Berlin LEZ 2011 assessment

This is the most recent assessment, which is after the introduction of phase 2 in 1.1.2010.

**Figure 15. LEZ emissions reduction of diesel particulate emissions** (based on Frankfurter Allee vehicle fleet)

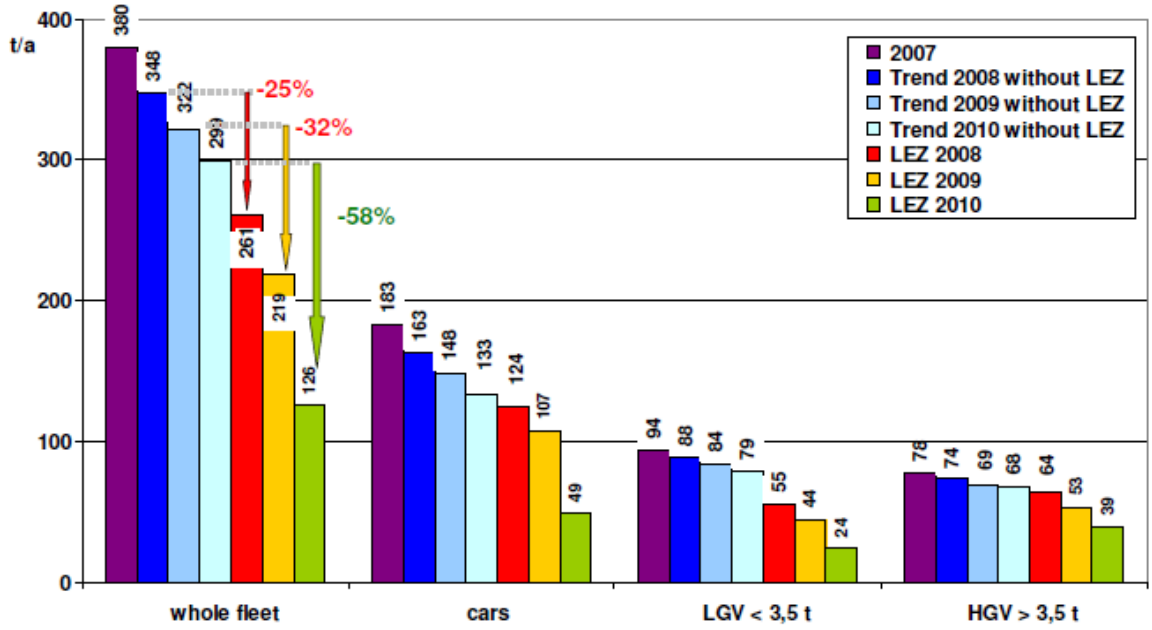


**Figure 16 LEZ emissions reduction of NOx emissions**

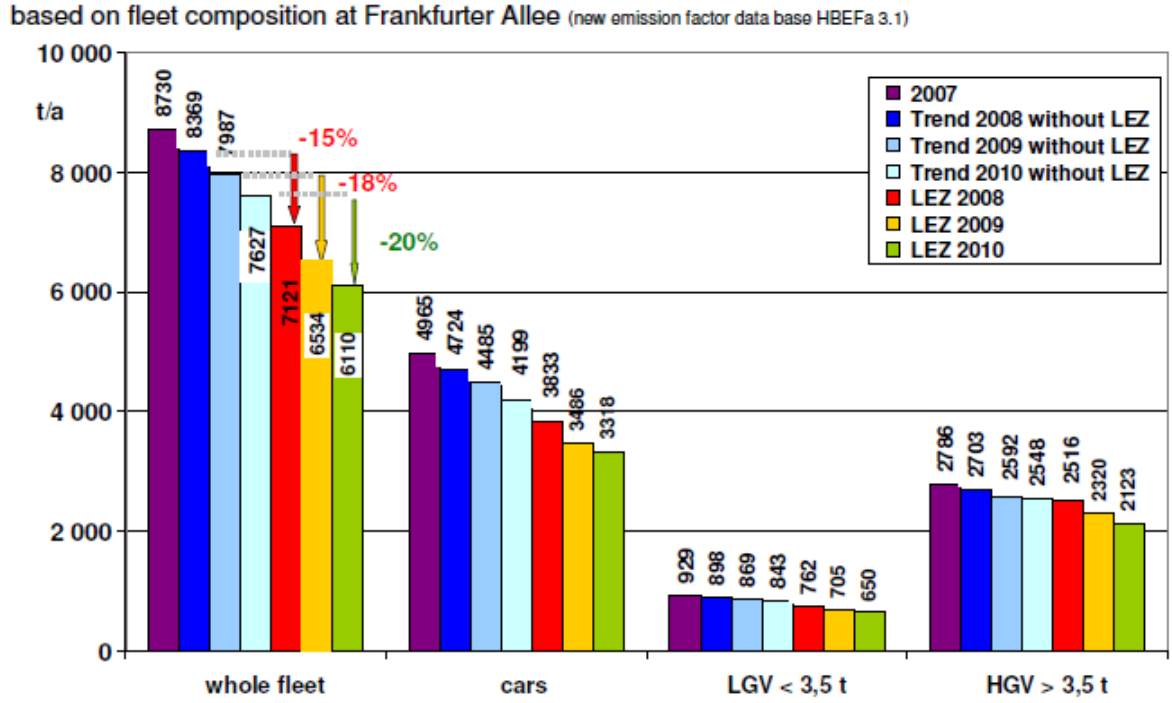
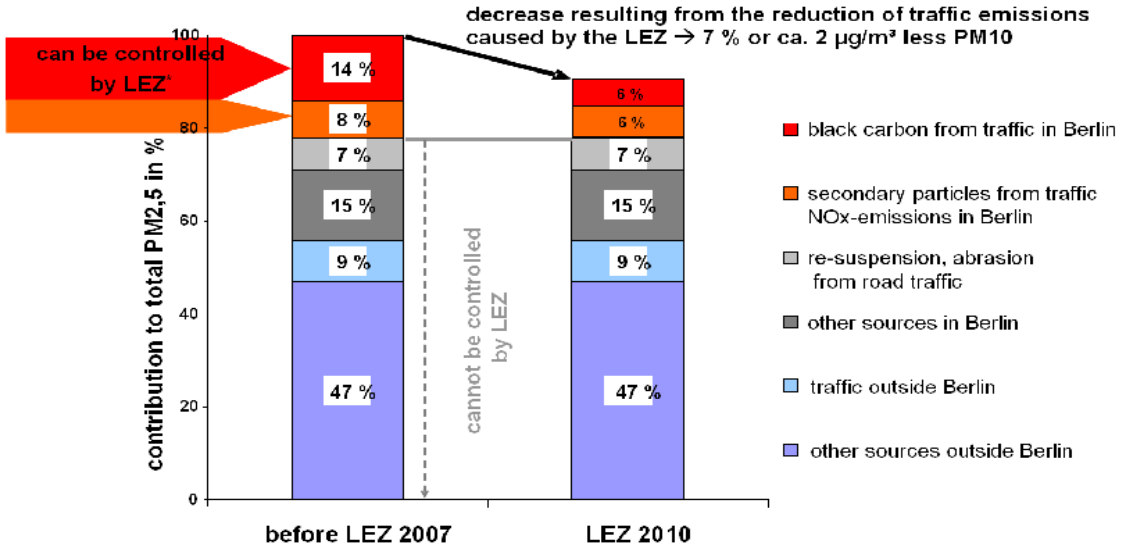



**Figure 17 $PM_{2.5}$ emissions reduction**

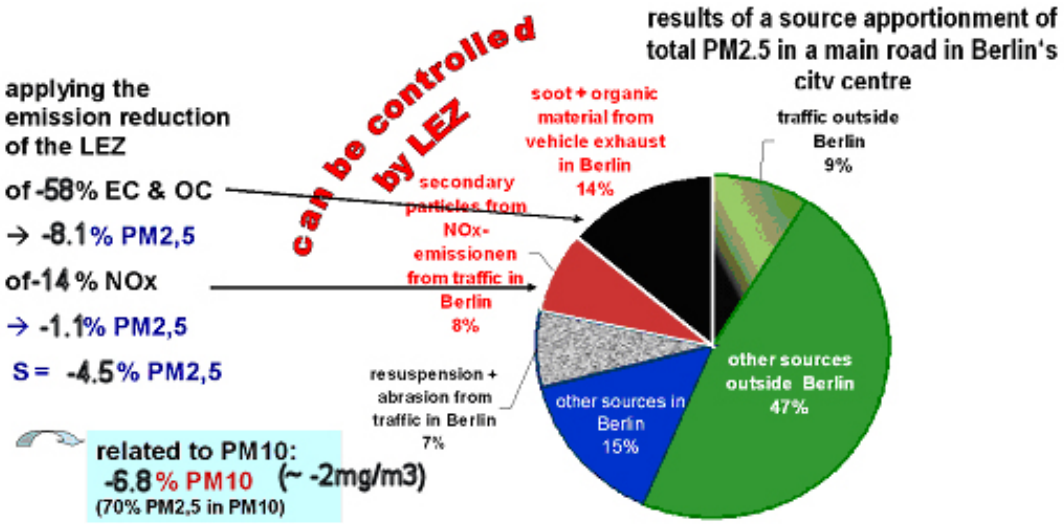



* related to **PM2,5**-levels in a busy main road in Berlin's city centre in 2007 before the LEZ

Figure 18 shows the different contributions to total annual mean $PM_{2.5}$ concentrations at a traffic air quality monitoring site[35]. The pollution from outside sources (in green), from non-transport emissions in Berlin (in blue), and from the non-exhaust PM-emissions by vehicles (in grey), is not affected by the LEZ. 14% of $PM_{2.5}$ at the kerbside is from urban traffic exhaust in Berlin and another 8% is secondary inorganic PM from urban traffic $NO_x$ emissions. While absolute concentrations of pollutants strongly depend on the meteorological conditions, the relative contribution of the source sectors, like those shown in the pie chart above, should be less prone to weather changes. Hence, the results of the 2007 source apportionment as a key to transpose the LEZ-related emission reduction into equivalent pollution reduction figures should produce a result fairly representative also for other years with a different meteorology.

35 The diagram has had updated figures added for the current year, hence the odd formatting

**Figure 18. Estimation of the LEZ impact on $PM_{2.5}/PM_{10}$ by applying the calculated LEZ-related emission reduction traffic exhaust $PM_{2.5}$**




The 2007 source apportionment study in sources of PM has been used to help assess the impact of the LEZ from monitoring data following the LEZ in 2008. Assuming linearity between emission reduction and the decrease of the concentration of the two LEZ-related parts of the $PM_{2.5}$, $PM_{2.5}$ concentrations would have been 4.5% lower, if the LEZ had been introduced in 2007. Given a 70% share of $PM_{2.5}$ in kerbside $PM_{10}$, the net reduction of $PM_{10}$ levels due to stage 1 of the LEZ amounts to 3.1%. Based on a statistical relation between annual mean levels and the number of exceedences of the 24h $PM_{10}$ limit value of 50 µg/m³, about 4 exceedence days could be said to have been prevented by the LEZ under the boundary conditions of the year 2007.

As of early 2009, no quantitative figure for the LEZ-effect has been able to be taken from a direct comparison of the $PM_{10}$ measurements before (i.e. 2007) and after (i.e. 2008). This is the case even if the LEZ-independent regional PM-background level was subtracted and the remaining urban increment were adjusted for any local changes in traffic volumes. There is still too much noise in the data resulting from varying weather conditions and other unknown factors, in order to allow the extracting of a statistically significant LEZ-related signal. More years monitoring will help clarify this. The reductions in other PM metrics will expect to be greater, due to the larger influence of traffic emissions on these metrics.

In comparison to 2007 before the LEZ, measured black carbon levels decreased by 14 or 16% in 2008, the first year with the LEZ in force. Measurements were taken at over 20 spots in and outside the LEZ. Figure 19 shows the trend of black carbon concentrations averaged among the measurements in and outside of the zone. The data were adjusted for any traffic volume changes and normalised to 2007 figures, so that percentage net reduction can be immediately obtained from the graph.

To qualitatively assess the weather dependency of the result, three parameters were chosen as a proxy for conditions in the boundary layer that are thought to determine the dispersion of fine particles, like soot. Low wind speed, days without precipitation and radon concentrations are most relevant. Figure 19 shows that despite the fact that dispersion conditions worsened in 2008, the rate of decline of black carbon concentrations was the same. Hence, this improvement of around 15% must be largely linked to the implementation of the LEZ.

**Figure 19. Normalised traffic adjusted black carbon (EC) concentrations averaged monitoring sites inside and outside of the LEZ**

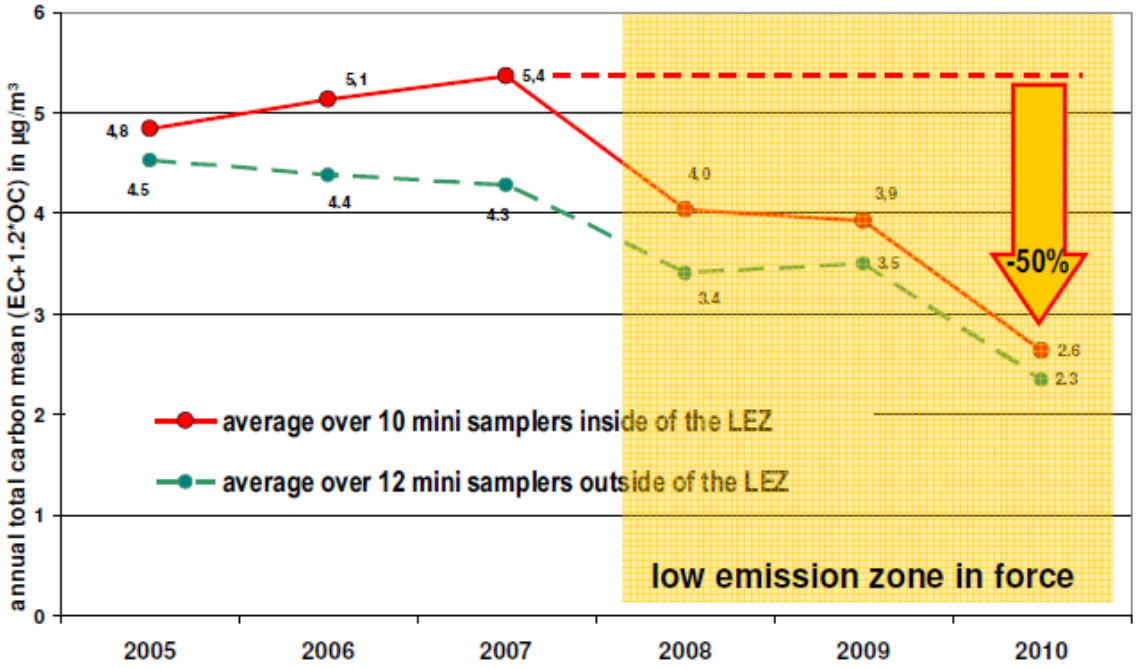
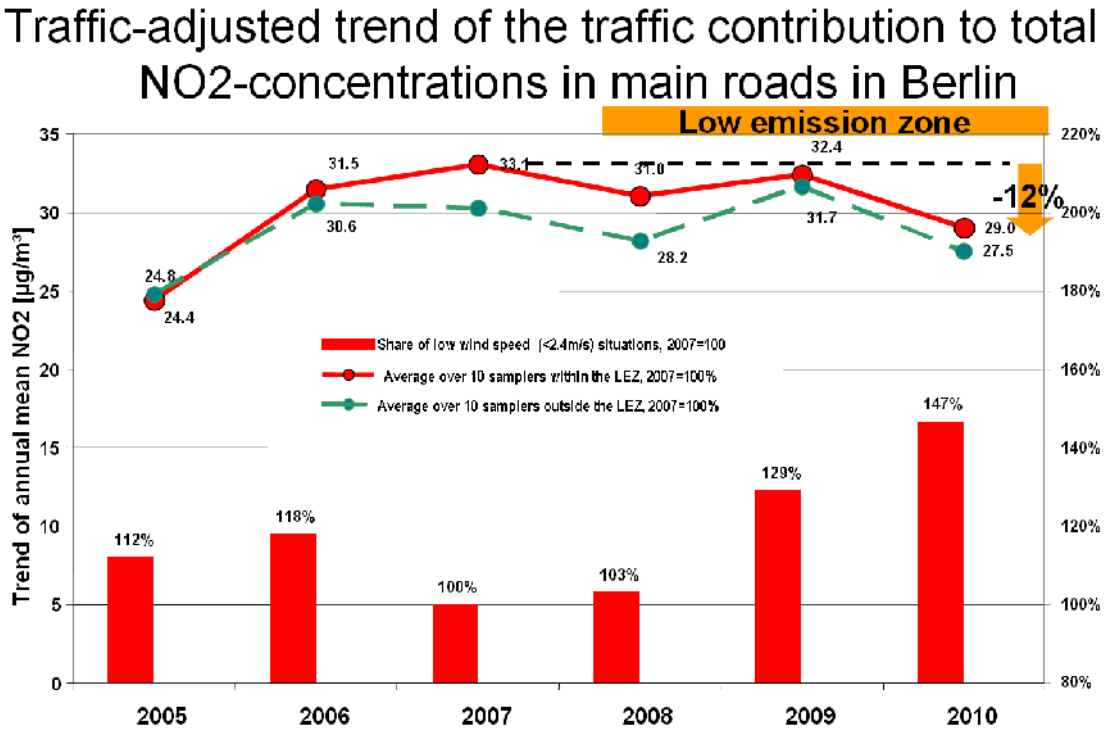



**Figure 19a. Updated Normalised traffic adjusted $NO_2$ concentrations averaged monitoring sites inside and outside of the LEZ**




### 20.1.2. Berlin LEZ 2009 assessment

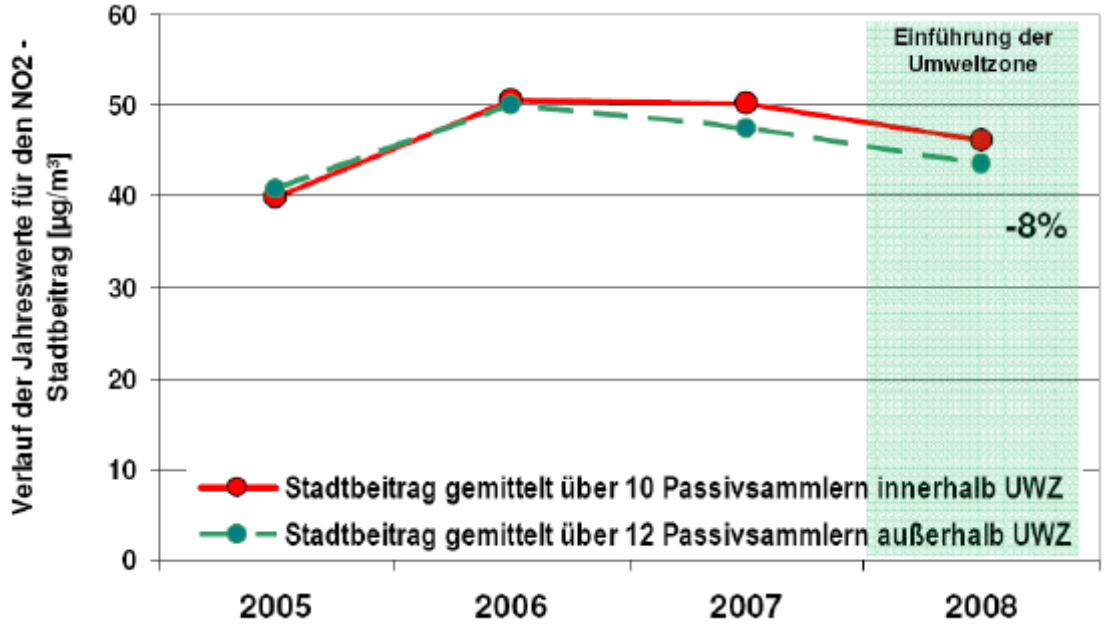
The LEZ phase 1 (Euro 2(PM) for diesel vehicles and Euro 1 for petrol vehicles inside the inner ring road) has achieved:

- $PM_{10}$ exceedences from 28 to 24 per year, diesel particulate concentrations by 14-22% and $PM_{10}$ concentrations by 3% on main roads (modelled). Similar figures were obtained for the Nordrhein-Westfalen LEZs.

- Despite an increasing share of direct $NO_2$-emissions, monitored $NO_2$ concentrations in Berlin have decreased by 6-10%, after several years without a visible downward trend. Traffic flow change adjusted $NO_2$-concentrations also decrease by 8%, a much larger reduction rate than in the year before. These adjustments were done linearly, without emissions factors.
- For $NO_2$, there is 8% reduction from tube monitoring, 10% from automatic monitoring, and 6% is from $NO_2$ tube taking off the fraction attributed to natural turnover.
- A net reduction of 24% of exhaust particle and 14% lower $NO_x$ emissions traffic.
- Significantly fewer pre-Euro 2 diesel and Euro 0 petrol vehicles in the Berlin vehicle fleet. 70% reduction in passenger cars and over 50% in commercial vehicles. Improvements are seen citywide, also in Berlin areas outside the LEZ.
- No effect on traffic flows. There was a reduction of traffic by 4% in the LEZ and 6% in the surrounding area, as a result of the peak in fuel prices in 2008 and of Berlin's transport policy to promote cleaner modes of transport.
- Black carbon concentrations on Berlin were more strongly affected with levels falling by around 14-6% as monitored including natural turnover, 11-13% if the impact of the natural turnover is taken off (using emissions factors).
- As weather conditions were even more stagnant in the first year of the LEZ, the observed improvement of the air quality can be largely allocated to the implementation of the LEZ.
- The results for stage 1 are consistent with projections based on model calculations, which gives confidence in its predictions for phase 2.

Below are the NO2 monitoring results for the Berlin LEZ inside and outside the LEZ. The monitors have been selected that are generally up-wind of the road, to give the 'town proportion' of the pollution. The measurement differences give an 8% reduction in NO2. Around 20% of the NO2 is imported, so this would suggest that the actual reduction from the LEZ is around 7%.

**Figure 20 Trend of the traffic-affected town proportion of the NO2 concentration on heavily traffic-ed streets inside and outside the LEZ** town proportion=roadside values – windward background concentrations (~10-12µg/m$^3$)




Key:
Green shading = Einführung der Umweltzone = introduction of the LEZ. Verlauf der Jahreswerte für den $NO_2$ Stadtbeitrag = annual average $NO_2$ for town proportion. Stadtbeitrag gemittelt über 10 Passivesammlern= town proportion averaged over 10 passive samplers. innerhalb = inside, außerhalb=outside, UWZ=LEZ.

### 20.1.3. Cologne

Cologne's LEZ was introduced in 2008 with Euro 2(PM) for diesel vehicles and Euro 1 for petrol vehicles since January 2008 inside the inner ring road. Results from the first year show that air quality concentrations have reduced by 7% ($PM_{10}$) and 1.2% ($NO_2$) more than the surrounding background (reduction of 0.5µg/m³ for $NO_2$).

**Table 11. Change in $NO_2$ measured by $NO_2$ diffusion tubes within the LEZ**

| Measurement station | Average 1-12/2007 (µg/m³) | Average 1-12/2008 (µg/m³) | Change (µg/m³) |
|---|---|---|---|
| **Clevischer Ring*** | 68 | 65 | - 3 |
| **Justinianstraße** | 56 | 53 | - 3 |
| **Neumarkt** | 53 | 54 | + 1 |
| **Tunisstraße** | 47 | 45 | - 2 |
| **Turiner Straße** | 51 | 50 | - 1 |
| **Hohenstaufenring** | 50 | 51 | + 1 |
| **Average** | **54.2** | **53.0** | **- 1.2** |

* comparison is 1.7.-31.12 in 2007 and 2008

The table below gives the change in $PM_{10}$ measurements in Turiner Straße with and without LEZ. In 2007 Turiner Straße had a daily vehicle flow of 44,174 vehicles, with 1.3 to 3% proportion of heavy and light goods vehicles. The measurement station only came into operation on the 29th March 2007, so the whole year can not be compared. $PM_{10}$ reduced by 4 µg/m³ and 17 exceedences of the limit value (compared with the surrounding urban background reducing by 4 µg/m³ and 7 exceedences).

**Table 12. Change in $PM_{10}$ measurements with and without LEZ**

| Comparison time | Average (µg/m³) | Number of days > 50 µg/m³ |
|---|---|---|
| **01.04.2007 – 31.12.2007** | 32 | 25 |
| **01.04.2008 – 31.12.2008** | 28 | 8 |
| **Change 2008 – 2007** | -4 | - 17 |

It is also possible that the reduction is influenced by a significant traffic change due to large building sites in 2008. Data in 2009 will be able to confirm these changes.

### 20.1.4. Baden-Württemberg

The weather in Baden-Württemberg in 2008 (red sticker) helped the improvement in air quality since the LEZs. LEZs are not a popular option with politicians or officials in Baden-Württemberg, but were implemented as no other option was seen to improve air quality. However, the tone of post-implementation press releases has been more positive. Nearly every vehicle has a sticker (so is at least Euro 2(PM) diesel or Euro 1 petrol) and violations of the LEZs are the exception.

Modelling gives a 15% reduction in $PM_{10}$ from vehicle emissions. This first phase of the LEZ affected 3-5% of vehicles, but these vehicles have city-driving emissions 7 times a vehicle with modern diesel emissions. Emissions were reduced and cleaner vehicles driven. For $PM_{10}$ there are other factors, including the mild winter for 2008 compared with 2007, but 22 from 29 air quality monitoring sites had lower measurements, but in 3 higher. In 2008 there were 15 monitoring sites exceeding the EU LVs. However, in the beginning of 2009, the Stuttgarter Neckartor (road) already had 42 exceedences before the end of February. It is modelled that $PM_{10}$ LVs will be met by the extension deadline with the action plan, except for the Stuttgarter Neckartor, using average weather conditions. The $PM_{2.5}$ LVs will be met.

In contrast to the positive story for $PM_{10}$, $NO_2$ has only marginally decreased in recent years, and the Baden-Württemberg Land states that the current action plan needs to be followed to achieve the $NO_2$ LVs.

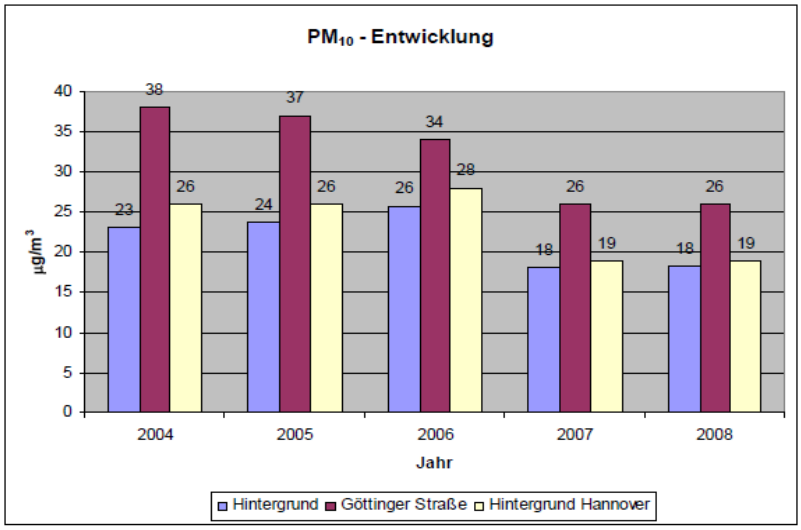
### 20.1.5. Hannover

LEZ on 1.1.2008, Euro 2(PM), 1.1.2009 Euro 3(PM), 1.1.2010 Euro 4(PM). The actual reduction so far has been 1%-2% for $PM_{10}$ and 5% for $NO_2$. For Hannover, there were no weather effects for $NO_2$ between the two years, and for $PM_{10,}$ there is an indication of weather-dependent improvement, but this is within the measurement uncertainties.

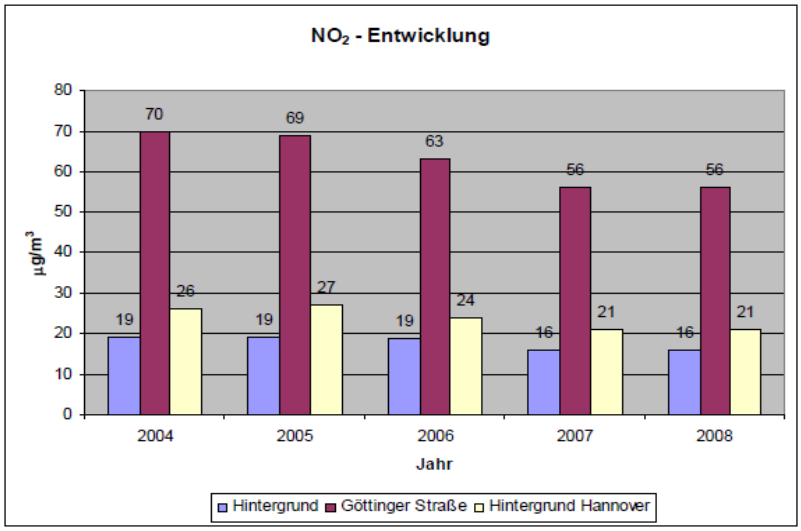
Comparing the air quality monitoring data for 2007 and 2008 for $NO_2$ and $PM_{10,}$ there is no significant difference (see Figure 21). However, if the impact of the LEZ was zero, the ratio between the averaged background monitoring sites from 2004-7 over the averaged background monitoring sites from 2008 should be the same as the averaged traffic monitoring from 2004-7 over the traffic-monitoring site for 2008. For Hannover, this is not the case, and the difference is the impact of the LEZ as given above. This method is used to take the variations due to weather, natural fleet turnover etc.

Hannover also analysed the LEZs in particular with respect to $NO_2$ as part of the legal challenge. The Court found that estimates of future $NO_2$ concentrations would reduce by around 10% was sufficient to be implemented. Annual average concentrations in the traffic-monitoring site in Hannover are 56 µg/m$^3$, and the LEZ should bring a reduction of around 4µg/m$^3$. The court stated that the effectiveness of the LEZ should be regularly re-assessed.

**Figure 21. Monitoring data for Hannover**




Grafik 1: Entwicklung der Belastung für $PM_{10}$




Grafik 2: Entwicklung der Belastung für $NO_2$

Key: Hintergrund=background, Straße=street, Entwicklung der Belastung=development of the concentration

### 20.1.6. Munich

According to the Bavarian Environment Ministry, the LEZ results in up to 5 fewer $PM_{10}$ exceedences., however this reduction is weather-dependent, so would be different given different weather conditions.

An academic research paper[36] analysing four months before and after the LEZ introduction (October-January), adjusting for meteorological conditions with a background station, a reduction of the relative $PM_{10}$ burden was seen, and the magnitude of the decrease was in line with that calculated by modelling. The decrease was small, but especially pronounced at traffic sites. However, 4 months is not sufficient to give a robust assessment of the LEZ impact.

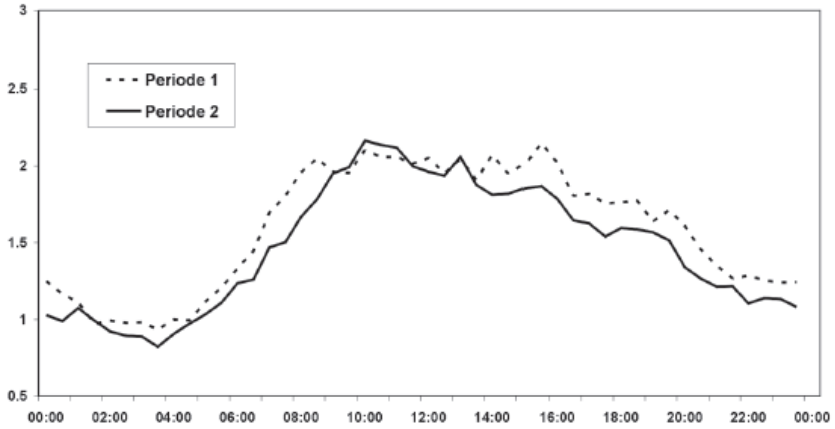
**Table 13. Change in $PM_{10}$ between before and after the LEZ introduction**

| Monitoring site (contribution of local traffic to $PM_{10}$) | Difference (%) in the PM half-hour average | Difference (%) in the relative PM concentration half-hour average* |
|---|---|---|
| **In the LEZ** | | |
| Stachus (29%) | 3.1 | -9.8 |
| Prinzregentenstraße (22%) | 7 | -12.3 |
| Lothstraße (6%) | 10.5 | -5.4 |
| **Edge of LEZ (middle ring road)** | | |
| Landshuter Allee (45%) | 6.8 | -8.9 |
| Luise-Kiesselbach-Platz (14%) | 12.5 | 3.9 |
| **Outside the LEZ** | | |
| Johanneskirchen (Reference) | 14.4 | 0 |

* the relative $PM_{10}$ pollution is the ratio of half-hourly average values of the measured $PM_{10}$ concentrations, compared to Johanneskirchen (reference), averaged over all half-hourly

The concentration reductions are greater in the more highly trafficked roads, and less in Lothstraße with low traffic. Landshuter Allee also has a lorry ban from February 2008, which helps explain the high reductions. Luise-Kiesselbach-Platz is in the main wind corridor between the surrounding area and Munich's city centre, which explains the lack of reduction there.

**Figure 22. Daily profile of $PM_{10}$ concentrations in the LEZ (Prinzregentenstraße),** periode1=before the LEZ, periode2=after




### 20.1.7. Bremen

Interviews with Bremen officials gave the following air quality measurements following the LEZ implementation:

36Led by the Helmholtz Zentrum München – Deutsches Forschungszentrum für Gesundheit und Umwelt [German Research centre for health and environment], Epidemiology Institute , together with colleagues from Augsburg and Munich Universities.

- 2% emissions reduction predicted.
- One monitoring site reduced by 6% for $PM_{10}$ and $NO_2$.
- implementing in phases will reduce the impact of the first stage in 2011 with Euro 4(PM) expect a significant impact
- Building work increased PM at one monitoring site
- Emissions increased on road a used as diversion – a lorry ban is now implemented on that road.

From the Bremen feasibility study, these modelling results are available, showing the improvement in air quality with the LEZ for 2010 for $NO_2$ and $PM_{10}$.

**Figure 23. Bremen $NO_2$** without (L) and with (R) LEZ in 2010 Key: Immissionen = concentration

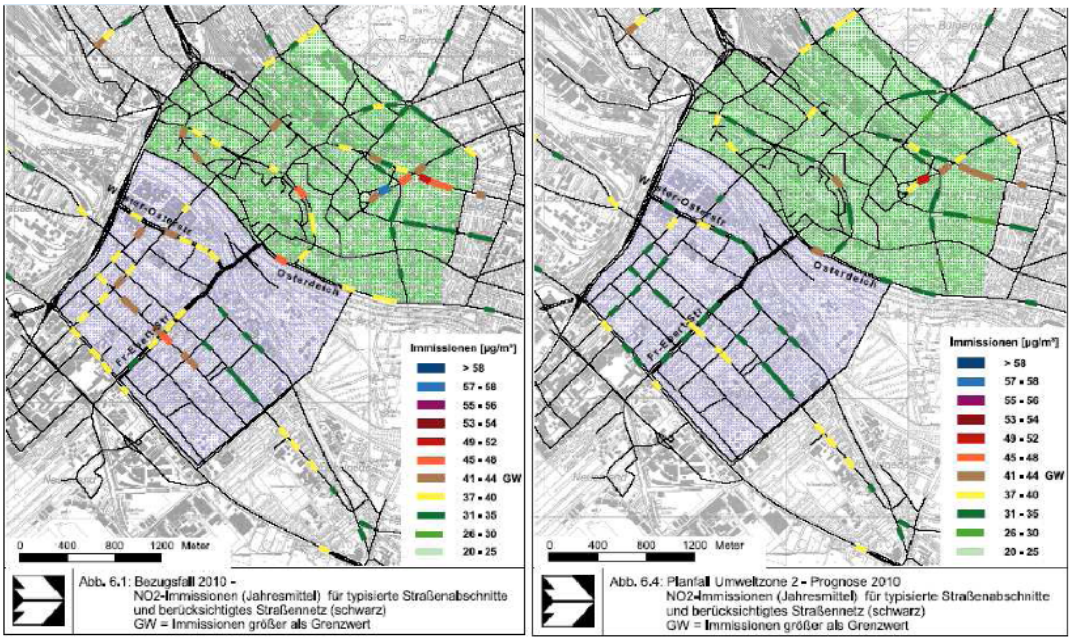
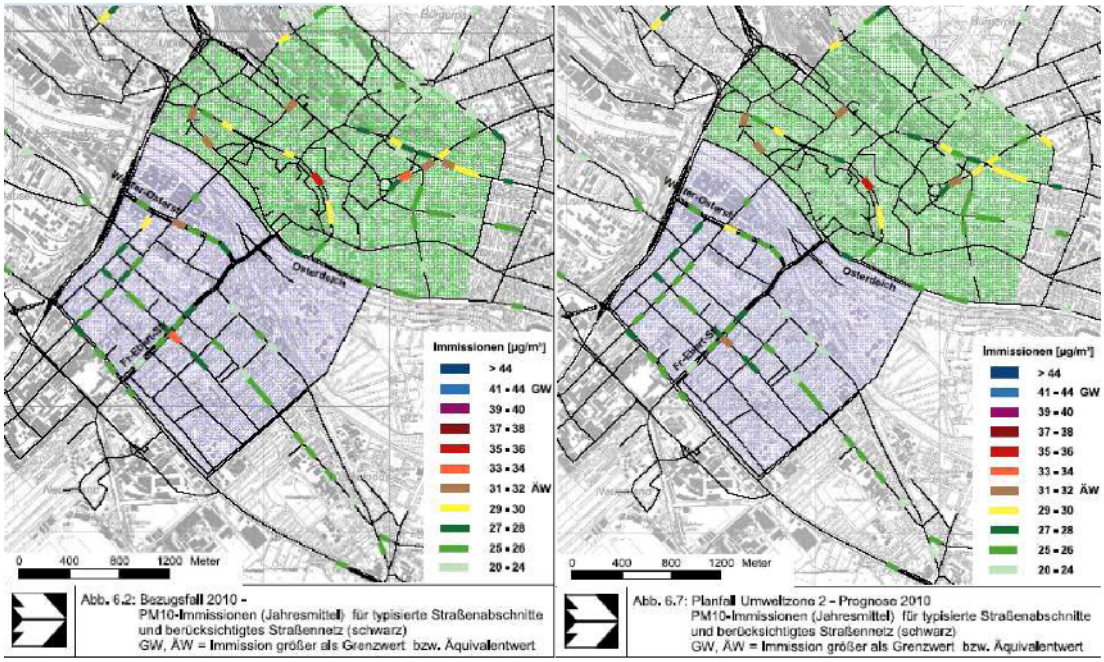



**Figure 24. Bremen $PM_{10}$ without (L) and with (R) LEZ in 2010**



## 20.2. The Netherlands

The Netherlands has produced 3 national reports on LEZs, in December 2008, 2009 and 2010, that were presented before Parliament. Data from all three has been included, and it should be noted that they used different methodologies. Dutch LEZs were implemented from July 2007 onwards, with an entry standard of Euro 2 and 3 with DPF or Euro 4 for HGVs. From 1.1.2010, the standard becomes Euro 3 with DPF or Euro 4, and from 1.7.2013 Euro 4.

### 20.2.1. Dutch 2010 monitoring report

Figure 25 shows the LEZ impact on lorry emissions in 2010 for different cities. It has been assumed that there is no traffic reduction in these calculations. However for smaller cities such as Delft and Maastricht (where there is no information) there may have been some traffic reduction, so greater emissions benefit.

**Figure 25. Effect of the LEZ on lorry emissions in 2010 (for different cities)**

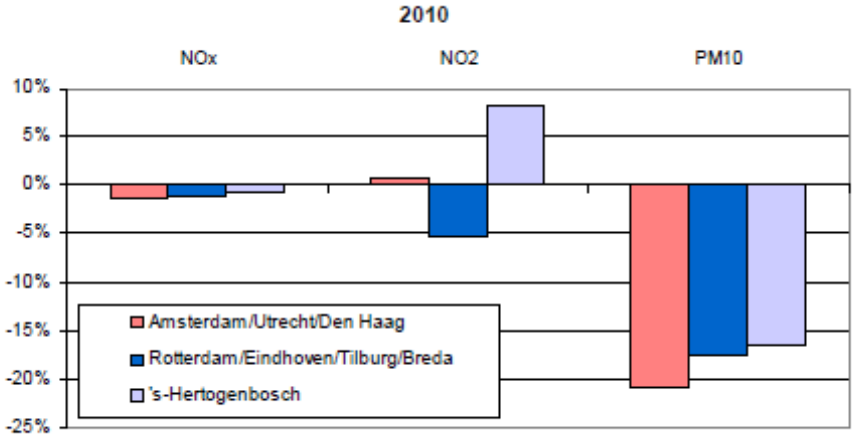
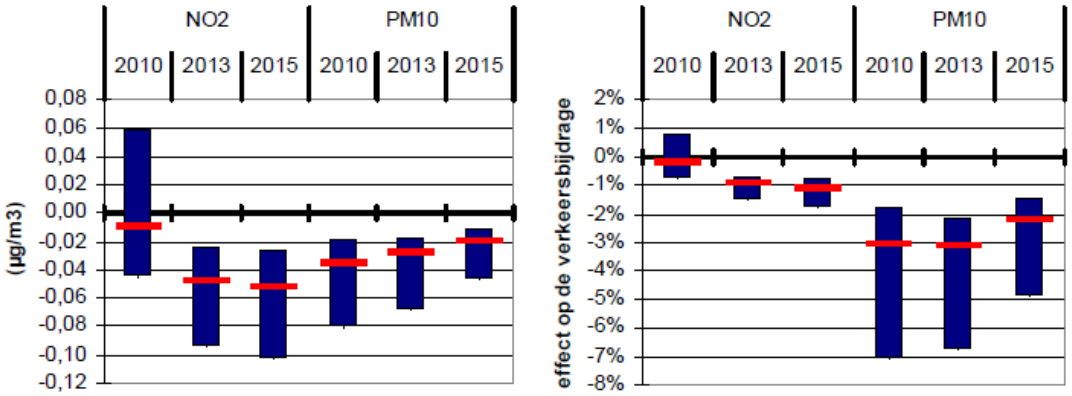



**Figure 26. Effect of the LEZ on concentrations (left) and traffic contributions (right)**




Key: red line is the average, the blue bar represents the variation in the different cities.

### 20.2.2. Dutch 2009 monitoring report

The impacts are modelled and, since the report was published, there has been new information about the impact of different Euro standards (see section 6.3) on $NO_x$. This has 'about halved' the LEZ impacts on $NO_2$. Further work is being undertaken to update these estimates, but is not yet available. This change has been updated on figures presented in this report by halving the impact. Even with this change, compared to other measures that improve air quality in cities, LEZs are still one of the most effective measures.

As a result of the LEZs, air quality improved. The $NO_2$-concentration alongside the roads with LEZs was on average 0.08µg/m$^3$ lower compared to the situation without an LEZ, increasing to 0.1µg/m$^3$

in January 2010. The concentration of particles ($PM_{10}$) decreased with 0.06 µg/$m^3$ as a result of the LEZs. Absolute total concentrations reduced by 0.4-0.2% for $PM_{10}$ and $NO_2$, traffic contribution by 2% and 1.5% respectively.

The range of impact depends on the number of lorries, but ranges from 0.05-0.13µg/$m^3$ for $NO_2$ and between 0.04 and 0.09µg/$m^3$ for $PM_{10}$. For roads with over 1,200 HGVs per day, the reduction in concentrations could increase to 0.03µg/$m^3$ for $NO_2$ and 0.15 µg/$m^3$ for $PM_{10}$. The impact on $NO_2$ increases significantly after 1st July 2013, the $PM_{10}$ impact is similar (without the impact of section 6.3).

**Figure 27. Average modelled roadside impact of LEZs on $NO_2$ and $PM_{10}$**

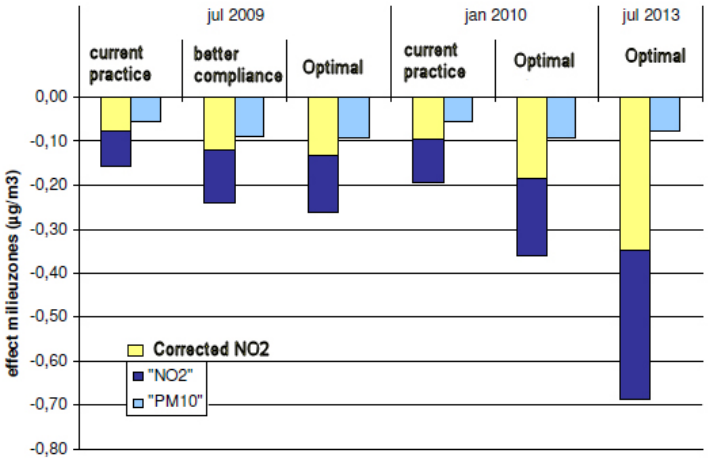
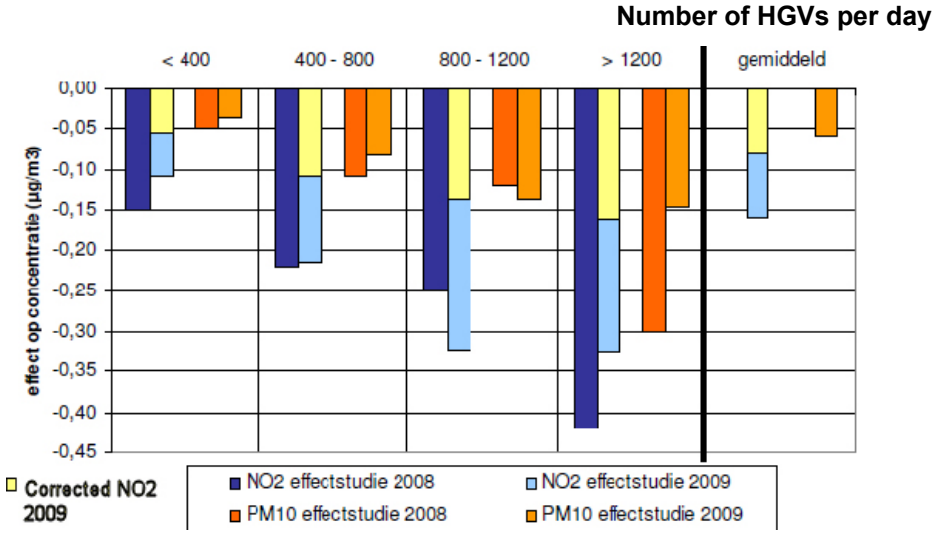



**Table 14. Average modelled exposure impact of LEZs on $PM_{10}$**

| | | µg/m³ | |
|---|---|---|---|
| current practice | better compliance | optimal | |
| Amsterdam | -0,06 | -0,09 | -0,10 |
| Breda | -0,07 | -0,11 | -0,12 |
| Eindhoven | -0,10 | -0,15 | -0,16 |
| Rotterdam | -0,04 | -0,05 | -0,06 |
| s Gravenhage | -0,07 | -0,11 | -0,12 |
| 's Hertogenbosch | -0,10 | -0,14 | -0,16 |
| Tilburg | -0,05 | -0,08 | -0,08 |
| Utrecht | -0,07 | -0,11 | -0,12 |
| Alle steden (SOM) | -0,06 | -0,09 | -0,10 |

Key: Alle steden=all cities (average)

**Figure 28. Difference between 2008 and 2009 studies**




Key: effectstudie=impact study, (gemiddeld=average)

The methodologies differ between the 2009 and 2008 studies, with more realistic streets being modelled, improved emissions factors (before the last change, section 6.3) and different methodologies. Therefore, it is not possible to say whether the impact of the LEZs has increased

impact between the two assessments. However, the increased compliance is likely to have increased the LEZ impact.

The national model (NSL) has also been used to assess LEZs, but it is believed that the study detailed here is more realistic, as:

- The vehicle fleet is older than the NSL assumes – the older the fleet the more effective the LEZ
- The impact of retrofitting is included (rather than assuming new-buy), which reduces the impact on $NO_x$ emissions
- NSL assumes better compliance

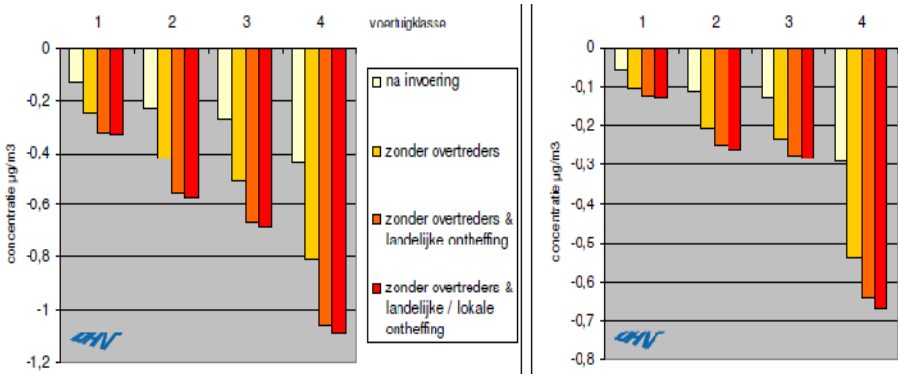
### 20.2.3. Dutch 2008 monitoring report

This assessment presents the modelled impacts from summer 2008. The impact has also been halved to account for the new Dutch emissions factors that have been identified subsequently.

Key results:

- Average effects that can be achieved (summer 2008) vary from 0.1 to 0.55µg/m$^3$ for $NO_2$ and 0.05 to 0.3µg/m$^3$ for $PM_{10}$. This represents a decrease of traffic-related $NO_2$ concentrations by 2.5%-5% and $PM_{10}$ of over 5%. In specific cases (e.g. street canyon), the effect will be higher. Predicted impacts were 0-1µg/m$^3$.
- Impact was limited by gradual enforcement and the fact that many exemptions for vehicles were granted where DPFs were not yet available.
- In 2007 there was minimal manual enforcement, often warning letters, for the first 6 months. Since the study, enforcement drives have increased and non-compliant vehicles without exemptions are fined €150.
- The number of exemptions reduced in January 2010 and increased enforcement has increased compliance. These factors expect to increase the air quality impact by a factor of 1.5 - 2. The LEZ second phase will also increase the impact, due to its tighter standard.

**Figure 29. Calculated change in $NO_2$ (left) and $PM_{10}$ (right) concentrations from the LEZs (2008)** - new emissions factors will half the impact.




Key:

| | |
|---|---|
| | After LEZ introduction |
| | With 100% compliance |
| | With 100% compliance and no rural exemptions |
| | With 100% compliance and no rural or local exemptions |
| **Type of street** | **Number of lorries /day (sample source)** |
| 1 | < 400 lorries (Biltstraat (Utrecht), Blaak (Rotterdam) |
| 2 | 400-800 lorries (Vestdijk (Eindhoven), Mauritskade [Den Haag]) |
| 3 | 800-1200 lorries (Graadt van Roggenweg (Utrecht), Binckhorstlaan [Den Haag]) |
| 4 | 1200-1600 lorries (Amsterdamse Veerkade [Den Haag]) |

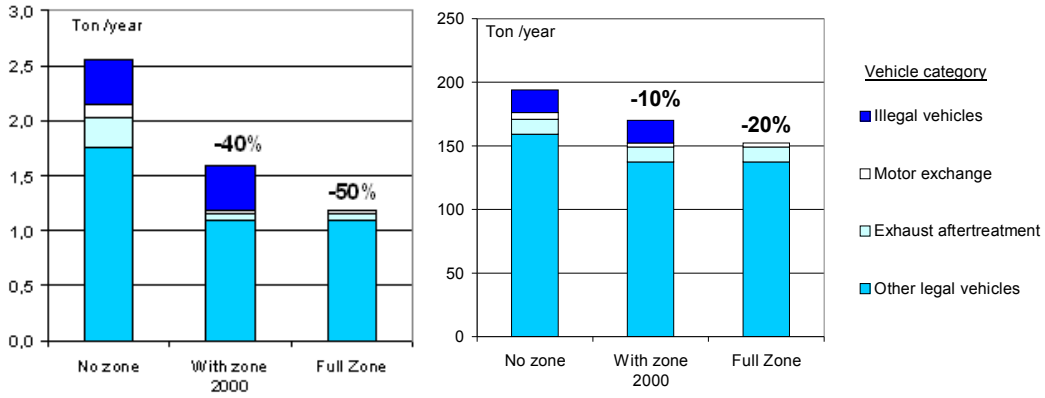
## 20.3. Sweden

### 20.3.1. Stockholm

The Stockholm LEZ has been in operation since 1996 and its impact was estimated in 2000 when the standard was maximum 8 years and Euro 2(PM). The impact has been assessed in 2000 and 2007 and is presented here. One would expect, as seen here for an LEZ in 2000, to have more impact than in 2007, as more of the more polluting older Euro standards (Euro 0, 1 and 2) were in the fleet to be affected by the LEZ. The 2000 study can no longer be seen as being representative of current LEZs.

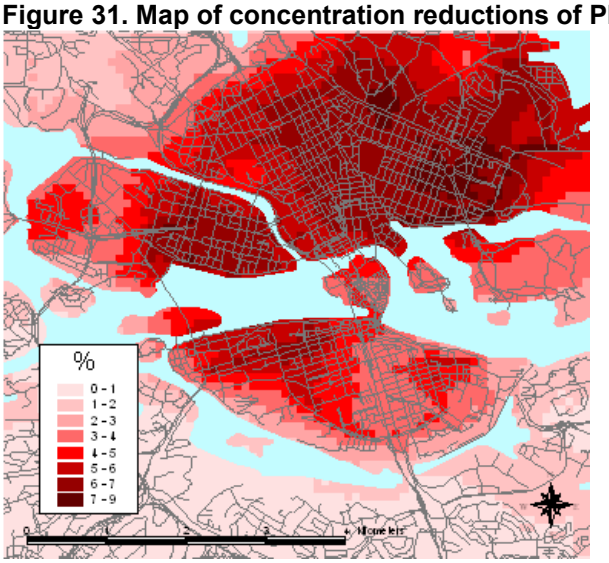
The estimated impact on emissions of particles ($PM_{10}$) and nitrogen oxides ($NO_x$) are given below for 2000. 'With zone' means with the LEZ as it has been implemented with the then current compliance rates. 'Full zone' means what would be achieved if there had been 100% compliance. Since 2000, there has been further work in Stockholm to improve compliance. 'Illegal vehicles' are now less than 5% of those entering the zone, so approaching a 'full zone' impact.

**Figure 30. Emissions of $PM_{10}$ (L) and $NO_x$ (R) from the Stockholm LEZ**




In looking at the impact on concentrations, the levels of $PM_{0.2}$ (particles less than 0.2µm in diameter that are of most concern to health) have been estimated. Since diesel particulate exhaust emissions are all $PM_{0.2}$, they are reduced by the LEZ. The map below represents the estimated percentage reduction in $PM_{0.2}$ concentrations in Stockholm due to the LEZ.

**Figure 31. Map of concentration reductions of $PM_{0.2}$, Stockholm LEZ**

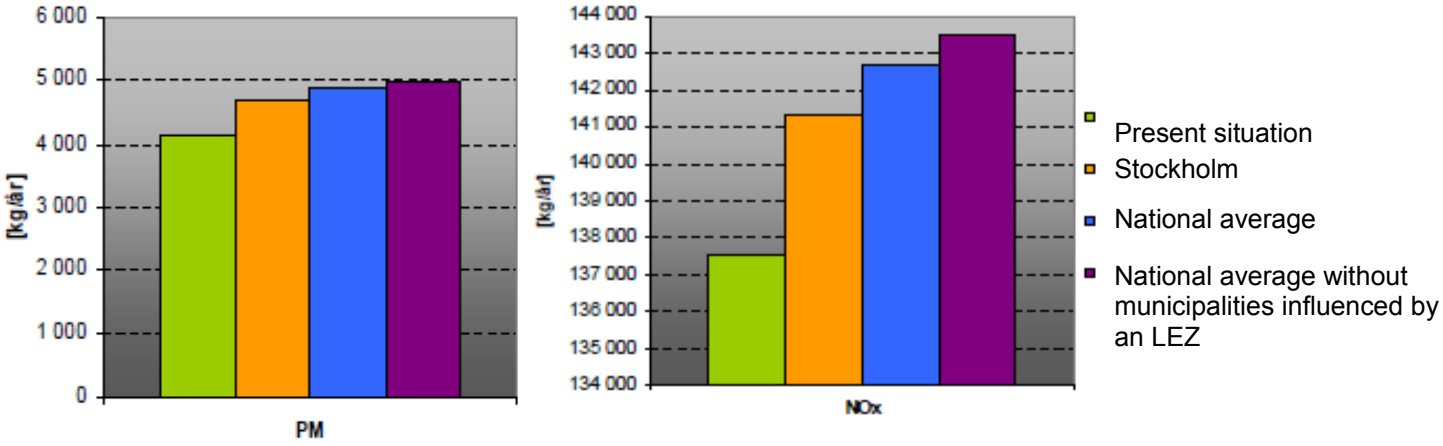



As can be seen from the variations in colour across map, emissions reduce differently in different parts of the city, depending on how heavy the traffic is, and therefore the impact of having cleaner lorries. The data represented in the map above shows that concentrations of $PM_{0.2}$ were reduced by between 0.5% and 9% with the LEZ, compared with what it would be without the LEZ. If all vehicles

had been fully compliant, then the concentrations would have been reduced by between 0.5% and 12% (see section 4.5.2).

The LEZ impact was assessed again in 2007, when the emissions standard was still 8 years and Euro 2, using a different methodology. The business as usual scenario (BAU) was harder to estimate, as the LEZ has been in operation for over 10 years. The LEZ was estimated to have reduced emissions of $NO_x$ 3%-4%, hydrocarbons (HC) 16%-21% and particles 13%-19% (depending which scenario is used for BAU). The impact is shown in the following figures. Buses operating in central Stockholm in 2007 (under agreement) are 82% ethanol, 17% biogas and 1% diesel[37].

**Figure 32. Emissions of PM (L) and $NO_x$ (R) in the LEZ in 2007**




### 20.3.2. Gothenburg

An assessment of Gothenburg's LEZ was undertaken in 2006. At that time, the LEZ had an entry standard of no lorries (>3.5T) over 8 years, with exemptions for vehicles that were alternatively fuelled and retrofitted with DPFs. Emissions were estimated, using the vehicle fleet as of 2004. In terms of percentage, there has been most impact on $PM_{10}$ emissions, but in terms of tonnage, the impact on $NO_x$ was greater. 'Relatively speaking, this is a lot compared with the measures discussed to further reduce $NO_x$ emissions' (quoted from report). The impacts were greater when assessed in 1996, as expected.

The LEZ seems to have had greatest effect, relatively speaking, for vehicles 3.5-16T, where emissions have been reduced by 67%. The increase of HC emissions is due to the increase in gas vehicles, and mainly methane. Table 15 gives further details.

37 Miljözon för tung trafik i Stockholm 1996-2007, Stockholm city

**Table 15. Impact of Gothenburg LEZ (2006)**

| | percentage | kg/year |
|---|---|---|
| Reduced emissions of carbon monoxide within the zone (CO) | 3.6 | 286 |
| Reduced emissions of hydrocarbons within the zone (HC) | 6.1 | 6,652 |
| Reduced emissions of nitrous oxide within the zone ($NO_X$) | 7.8 | 13,229 |
| Reduced particle emissions within the zone (PM) | 33.2 | 2,767 |

| | HC kg/year | CO kg/year | $NO_X$ kg/year | PM kg/year |
|---|---|---|---|---|
| With environmental zone – Bus | 4245 | 39018 | 55712 | 2070 |
| Without environmental zone – Bus | 3643 | 42619 | 60830 | 3239 |
| With environmental zone – Heavy-duty vehicle < 16 tons | 311 | 3458 | 7420 | 187 |
| Without environmental zone – Heavy-duty vehicle < 16 tons | 577 | 4715 | 9362 | 566 |
| With environmental zone – Heavy-duty vehicle > 16 tons | 3166 | 59465 | 92299 | 3312 |
| Without environmental zone – Heavy-duty vehicle > 16 tons | 3788 | 61259 | 98468 | 4531 |
| With environmental zone - Total | 7722 | 101941 | 155431 | 5569 |
| Without environmental zone - Total | 8008 | 108593 | 168660 | 8336 |
| **Environmental gain with environmental zone** | **286** | **6652** | **13229** | **2767** |

### 20.4. Denmark

The Danish LEZs have been implemented from September 2008 requiring DPF to be fitted to Euro 2 or older HDVs. From 1.7.2010, this becomes fitting a DPF to Euro 3 or older, and from 1.7.2013, the entrance requirement is Euro 4. This is therefore aimed more specifically at PM than most LEZs. The impact of Copenhagen's LEZ was assessed on behalf of the Danish Transport Ministry in 2009, using modelling data for 138 busy streets, and monitoring data was used for model validation[38]. Detailed results are shown in the tables below.

Analysis of Copenhagen's LEZ found that total $NO_x$ emissions reduced by 17% in 2010, directly emitted $NO_2$ was reduced by 16% and the number of sites which were in exceedence of the $NO_2$ limit value in 2010 reduced from 65 to 35.

Total $PM_{10}$ emissions are reduced by 9% and total $PM_{2.5}$ emissions by 16% in 2010. On average, $PM_{10}$ concentrations in the 138 streets were reduced by 0.7 µg/m$^3$ (2.5%) and $PM_{2.5}$ concentrations by 0.7 µg/m$^3$ (3.5%). Few of the 138 streets are expected to exceed the annual limit value for $PM_{10}$ of 40 µg/m$^3$ in 2010-2020. The limit value for $PM_{2.5}$ of 25 µg/m$^3$ in urban background in 2015 is not expected to be exceeded.

38Jensen, S.S., Ketzel, M., Wåhlin, P., Palmgren, F., Berkowicz, R. (2009): How Does the Environmental Zone in Copenhagen Affect Air Quality of NO2, PM10 and PM2.5? in Hu, R.-M., Khaiwal, R., Chemel, C., Newbold, J., Incecik, S., Kahya, C., Sokhi, R.S. (editors) Proceedings of Short Papers at the 7th International Conference on Air Quality - Science and Application, March 24-27, 2009, Istanbul. ISBN: 978-1-905313-64-8.

Cost-benefit analyses based on reduction of population exposure to $PM_{2.5}$ have also shown positive results, despite modest reductions in $PM_{2.5}$ concentrations[39]. From pre-study impacts, the LEZ is expected to reduce Copenhagen's traffic pollution by 20% in 2010, and annual health benefits after 1st July 2010 is expected to give:

- 150 fewer premature deaths
- 150 fewer hospital admissions for respiratory and circulatory diseases
- 750 fewer bronchitis attacks
- 8,000 fewer asthma attacks
- 90,000 fewer days of restricted activity due to respiratory diseases

This corresponds to a decrease of $PM_{2.5}$ concentrations in Copenhagen urban background by 0.1-0.2 $\mu g/m^3$ (and a higher reduction along roads).

Emissions factors are from EU COPERT 4, primary $NO_2$ estimated as 18% in 2010, 25% in 2015 and 24% in 2020. It is assumed that Euro 0-2 HGVs are replaced with new Euro 5 vehicles and Euro 0-1 buses and 50% of Euro 2 buses are also replaced with Euro 5. Since $NO_x$ emissions were significantly lower for Euro 5 compared to Euro 0-2, this has a profound impact on emissions and concentrations – however, this may based on more recent information not be the case.

39Palmgren, F., Glasius, M., Wåhlin, P., Ketzel, M., Berkowicz, R., Jensen, S.S., Winther, M., Illerup, J.B., Andersen, M.S., Hertel, O., Vinzents, P.S., Møller, P., Sørensen, M., Knudsen, L.E., Schibye, B., Andersen, Z.J., Hermansen, M., Scheike, T., Stage, M., Bisgaard, H., Loft, S., Lohse, C., Jensen, K.A., Kofoed-Sørensen, V. & Clausen, P.A. 2005a. Particulate Air Pollution in Denmark. Danish Environmental Protection Agency. Report 1021: p84 and NERI 2006. Environmental and social costs of environmental zones in Denmark. Note by Danish National Environmental Research Institute, July 2006.

**Table 16 Modelled impacts of Copenhagen's LEZ**

Table 1. Modelled average annual $NO_2$ levels at 138 streets in Copenhagen and at two selected streets with air quality monitoring. Street concentrations and urban background concentrations are shown.

| Scenario | Street levels at 138 streets ($\mu g/m^3$) | Background levels at 138 streets ($\mu g/m^3$) | No. of exceedances of $NO_2$ limit value (over 40 $\mu g/m^3$) | Street level at H.C. Andersens Boulevard ($\mu g/m^3$) | Background level at H.C. Andersens Boulevard ($\mu g/m^3$) | Street level at Jagtvej ($\mu g/m^3$) | Background level at Jagtvej ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|
| 2010 Reference | 39.9 | 18 | 65 | 53.3 | 20.7 | 45.2 | 19.6 |
| 2015 Reference | 34.9 | 16.4 | 22 | 47.3 | 18.6 | 39.2 | 17.7 |
| 2020 Reference | 27.3 | 14.6 | 3 | 37.1 | 16.1 | 30.4 | 15.5 |
| 2010 EnvZone | 36.5 | 17.0 | 35 | 48.4 | 19.3 | 41.6 | 18.3 |
| 2015 EnvZone | 33.5 | 16.0 | 15 | 44.2 | 18.0 | 37.0 | 17.1 |
| 2020 EnvZone | 27.1 | 14.5 | 2 | 35.1 | 15.9 | 29.1 | 15.3 |

Table 2. Total $NO_x$ emissions for vehicle categories in reference scenario and with environmental zone requirements. Index for reference scenario is 100 in 2010. Direct $NO_2$ fractions are also shown.

| Year | Scenario | Passenger cars (Index) | Vans (Index) | Trucks <= 32t (Index) | Trucks > 32t (Index) | Buses (Index) | Total (Index) | Direct $NO_2$ fraction (%) | $NO_2$ emissions (Index) |
|---|---|---|---|---|---|---|---|---|---|
| 2005 | Reference | 137 | 107 | 104 | 106 | 115 | 119 | 7.4 | 49 |
| 2010 | Reference | 100 | 100 | 100 | 100 | 100 | 100 | 18.0 | 100 |
| 2015 | Reference | 74 | 75 | 77 | 76 | 78 | 75 | 25.0 | 105 |
| 2020 | Reference | 52 | 49 | 48 | 46 | 50 | 50 | 24.5 | 68 |
| 2010 | EnvZone | 100 | 100 | 62 | 65 | 71 | 83 | 18.4 | 84 |
| 2015 | EnvZone | 74 | 75 | 60 | 62 | 66 | 68 | 25.4 | 96 |
| 2020 | EnvZone | 53 | 49 | 43 | 43 | 47 | 48 | 24.6 | 66 |

Table 3. Modelled average annual street and urban background concentrations of $PM_{10}$ and $PM_{2.5}$ at 138 streets in Copenhagen.

| Year | Scenario | $PM_{10}$ street levels at 138 streets ($\mu g/m^3$) | $PM_{10}$ background levels at 138 streets ($\mu g/m^3$) | $PM_{2.5}$ street levels at 138 streets ($\mu g/m^3$) | $PM_{2.5}$ background levels at 138 streets ($\mu g/m^3$) |
|---|---|---|---|---|---|
| 2010 | Reference | 29.1 | 23.1 | 20.0 | 16.7 |
| 2015 | Reference | 28.6 | 23.0 | 19.3 | 16.7 |
| 2020 | Reference | 28.3 | 23.0 | 18.9 | 16.6 |
| 2010 | EnvZone | 28.4 | 23.0 | 19.3 | 16.7 |
| 2015 | EnvZone | 28.2 | 23.0 | 19.0 | 16.6 |
| 2020 | EnvZone | 28.2 | 23.0 | 18.8 | 16.6 |

Table 4. Total emissions of $PM_{10}$ NonExhaust, $PM_{2.5}$ NonExhaust, PM Exhaust emissions, $PM_{10}$ and $PM_{2.5}$ in reference scenario and with environmental zone requirements. Index for reference scenario is 100 in 2010.

| Year | Scenario | $PM_{10}$ NonExh (Index) | $PM_{2.5}$ NonExh (Index) | PMExh (Index) | $PM_{10}$ (Index) | $PM_{2.5}$ (Index) |
|---|---|---|---|---|---|---|
| 2005 | Reference | 84 | 85 | 110 | 93 | 101 |
| 2010 | Reference | 100 | 100 | 100 | 100 | 100 |
| 2015 | Reference | 108 | 107 | 72 | 96 | 85 |
| 2020 | Reference | 116 | 116 | 54 | 95 | 77 |
| 2010 | EnvZone | 100 | 100 | 74 | 91 | 84 |
| 2015 | EnvZone | 108 | 107 | 60 | 92 | 77 |
| 2020 | EnvZone | 116 | 116 | 49 | 94 | 73 |

### 20.5. London pre mid 2010

The initial phase of the London LEZ accountability study has identified a clear impact of the policy intervention on ambient pollution concentrations. Initial analysis of air quality monitoring data suggest a significant decrease in concentrations of CBLK (black smoke) and non-regional $PM_{2.5}$ at roadside locations of 15% or 1$\mu g/m^3$ per year (comparing the two years before LEZ introduction with the one year following it). The change was less well defined in central London where the proportion of taxis and buses (that are not affected by the scheme) is higher. The buses already met the LEZ standards before its introduction. Source apportionment of $PM_{10}$ revealed an underlying long-term downward trend in secondary and natural $PM_{10}$ (around 0.5$\mu g/m^3$ per year), but an increase in primary $PM_{10}$ (up to 0.6$\mu g/m^3$ per year), contradictory to emissions inventory projections. No evidence of an LEZ-related impact on primary $PM_{10}$ was found[40].

40Ben Barratt Abstract, Kings College London October 2009, http://aaarabstracts.com/specialty/viewabstract.php?paper=74

### 20.6. Italy

In Italy the winter LEZs seem to have been run on a low-key basis, with no monitoring reports found in the public domain. The exception is the Milan Ecopass with a high profile and monitoring reports.

#### 20.6.1. Milan Ecopass[41]

Milan's Ecopass is somewhat different from other LEZs, as it is a single scheme that combines a congestion charge with an LEZ, which operates in addition to the Lombardia LEZ which bans the oldest vehicles. For the Ecopass, in general, Euro 3 vehicles are allowed free access, whereas others are charged (with exceptions, see the LEEZEN website). The traffic has reduced on average for 2008 by 14.4% in the Ecopass area, and 3.4% in the whole of Milan in the year since its introduction. The Ecopass scheme was assessed during its first year (2008).

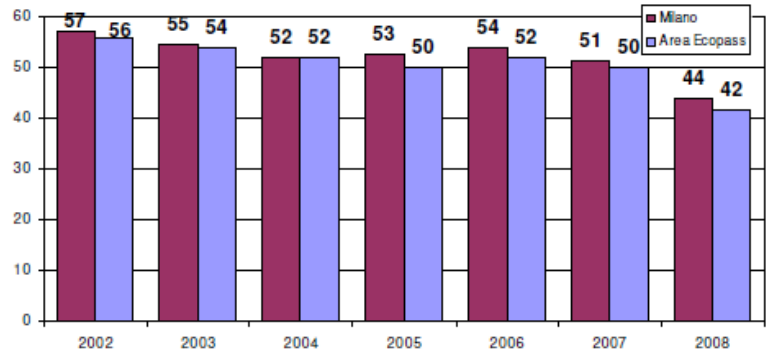
The impact on estimated emissions of the Ecopass scheme is significant. However, without detailed analysis, which is not available, it is not possible to state categorically the influence of the scheme on air quality concentrations over-and-above changes in air quality from other factors. The Ecopass scheme is estimated to have reduced total $PM_{10}$ emissions by 14%, $NO_x$ emissions by 11% and $CO_2$ emissions by 9%.

The figures below show the measured concentrations of $PM_{10}$ have reduced in 2008 compared with the previous years (with over 75% monitoring capture data); Table 17 shows this in statistical form, and a significant reduction in $PM_{10}$ for 2008 compared to the previous years.

**Table 17. Statistical data on $PM_{10}$ measurements 2002-8**

| Measurement | Ecopass area | Outside Ecopass area |
|---|---|---|
| Annual average $PM_{10}$ 2002-7 | 52 µg/m$^3$ | 54µg/m$^3$ |
| Annual average $PM_{10}$ 2008 | 42 µg/m$^3$ | 44 µg/m$^3$ |
| *% reduction annual average $PM_{10}$* | *19.00%* | *15.00%* |
| No. $PM_{10}$ LV exceedences 2002-7 | 140 | 148 |
| No. $PM_{10}$ LV exceedences 2008 | 78 | 102 |
| *% reduction in LV exceedences* | *-44.00%* | *-31.00%* |

**Figure 33. Annual average $PM_{10}$ concentrations in the Ecopass area (blue) and Milan (reddish).**




41 MONITORAGGIO ECOPASS, Gennaio – Dicembre 2008, Milan city authority

**Figure 34. Number of days exceeding the $PM_{10}$ Limit Value of 50µg/$m^3$ in the Ecopass area (blue) and Milan (reddish).**

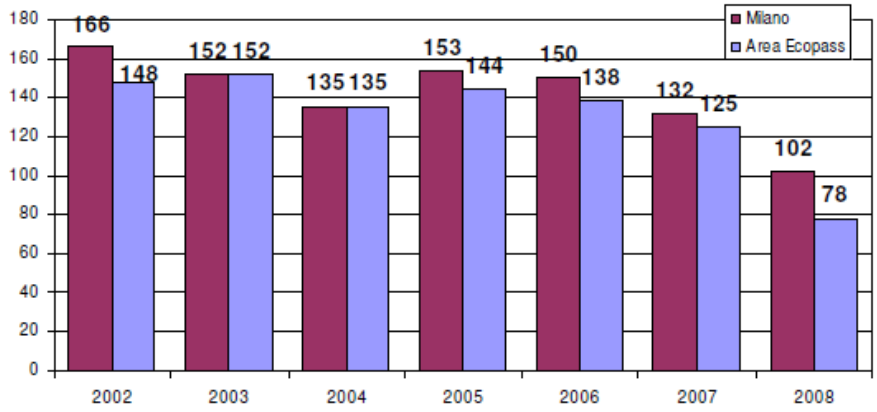
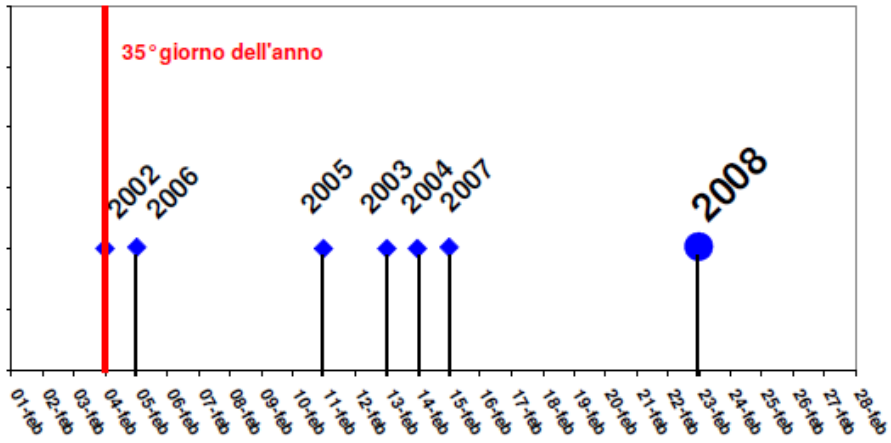



**Figure 35. Date at which the 35 $PM_{10}$ exceedences were reached, by year.**




### 20.7. Different LEZ scenarios

There are various sources of modelling and research for different LEZ scenarios. These are presented below.

#### 20.7.1. Dutch van and car LEZs

Cities in the Netherlands may well include vans in LEZs from 2013, and there has been investigation as to the potential impact this could achieve. TNO research found that, in the case of vans, the earliest standard that would be effective is Euro 4, so the earliest this could be implemented is 2013 (when the LEZ covenant has Euro 4 emissions standards). Vans emit 40% of $PM_{10}$ and 25% of $NO_x$ in Amsterdam.

Loans for the purchase of new vans could be available for those up to 130% of the national minimum income. This is due to Euro 3 vans having higher primary $NO_2$ emissions than previously believed. This could mean older vans being banned from LEZs, but those with increased $NO_2$ emissions being allowed in, with an adverse effect on $NO_2$ concentrations. LEZs for vans need to be considered in terms of timing and design, such as after 2013 when an LEZ for vans could contribute to a reduction in $NO_2$. It should be noted that subsequent work in Germany it was found that retrofitting light duty Euro 3 vehicles with (partial) DPFs reduced the $NO_2$ if retrofitting of vans is allowed.

Amsterdam city investigated implementing LEZs for vans and cars. Amsterdam meets the $PM_{10}$ LVs, but not those for NO2[42]. In the case of cars, TNO's research showed the effect of electric

42www.nieuwamsterdamsklimaat.nl/milieuzone

transportation in 2015 more than twice as large as the effect of an LEZ for cars for $NO_2$[43]. The municipality will invest €10m in electric transportation and, in 2015, 10,000 electric cars are expected to be driving in Amsterdam. Charging points are being implemented, agreements are being entered into with industry and other private organisations on the use of electric transportation, as well as grants under an electric city plan. Other measures to improve health include 400 individuals receiving €300 to give up their car parking space, and other parking measures.

### 20.7.2. Danish DPF-LEZ scenarios

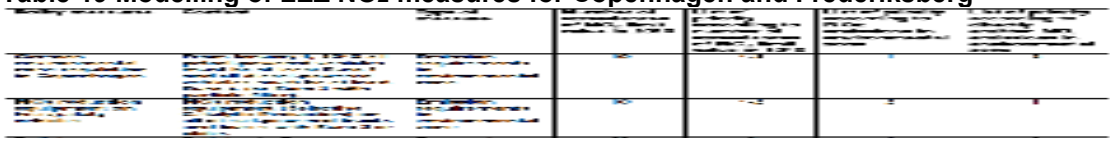
In 2007, the Danish National Environmental Institute estimated Danish LEZ scenarios for LEZs, two of which require retrofitting of diesel particulate filters (DPFs) to heavy duty vehicles (HDVs) and no other action. These are very effective at reducing PM, but can increase $NO_2$, as DPF certification schemes often do not control primary $NO_2$ (see 3.2.2). This, together with potential EU-legal issues suggests that the Euro standards should be used for the emissions standards. Danish modelling of their LEZs, that include DPF retrofitting for later Euro standard vehicles and replacing of earlier Euro standard vehicles, has a positive impact on $NO_2$.

**Table 18 Danish LEZ DPF-focused scenarios**

| Scenario | Annual average concentrations of NO ($\mu g/m^3$) at 138 street sections | Number of street lines with an annual average $NO_2$ greater than 40 µg/m |
|---|---|---|
| LEZ with DPF on HDVs, 2010 | 113% | 112% |
| LEZ with DPF on half of the HGVs and new vehicles, 2010 | 102% | 104% |
| LEZ with DPF on HDVs plus SCR on HDV, 2010 | 93% | 88% |
| Scrapping of old petrol vehicles, 2010 | 96% | 97% |
| LEZ with DPF on HDVs, plus the scrapping of old petrol vehicles, 2010 | 85% | 48% |
| LEZ with DPF for HDVs, plus the scrapping of old petrol vehicles, 2015 | 90% | 54% |

Modelling of $NO_2$ measures for Copenhagen and Frederiksberg gave German-style LEZs and $NO_x$ retrofits for HDVs as the most promising measures. The two LEZ-related items are in the figure below.

**Table 19 Modelling of LEZ $NO_2$ measures for Copenhagen and Frederiksberg**



## 20.8. Vehicle $NO_2$ emission aspects

### 20.8.1. Primary $NO_2$ issues from Hannover's legal challenge

In the legal case for Hannover, the fact that the LEZ had a positive impact for $NO_2$ was key. As the German cities approach meeting the $PM_{10}$ limit values (LVs), the LEZ are becoming more important for the $NO_2$ LVs. They found that the DPFs fitted to Euro 3 light duty (LD) vehicles reduced the primary $NO_2$. This means that the Euro 4(PM) standard LEZs for all vehicles, including retrofitting many Euro 3 light duty vehicles, the net impact of the LEZ is positive.

DPF certification for LEZs needs to be certified on the basis of the Euro standards, and the rule has been interpreted as saying that they are not allowed to refer to $NO_2$, only $NO_x$, however the London and Italian certifications now also control primary $NO_2$. Some passive regenerative diesel particulate filters (DPFs) used on HDVs (heavy-duty vehicles) over 3.5T increase primary $NO_2$ emissions from around 10% to 20-40%. Active DPFs do not increase primary $NO_2$, neither do all passive DPFs.

43 TNO-rapport, MON-RPT-033-DTS-2009-03095, Elektrisch Vervoer in Amsterdam, Onderbouwing van ambitie en doelstelling en adviezen voor een effectieve aanpak

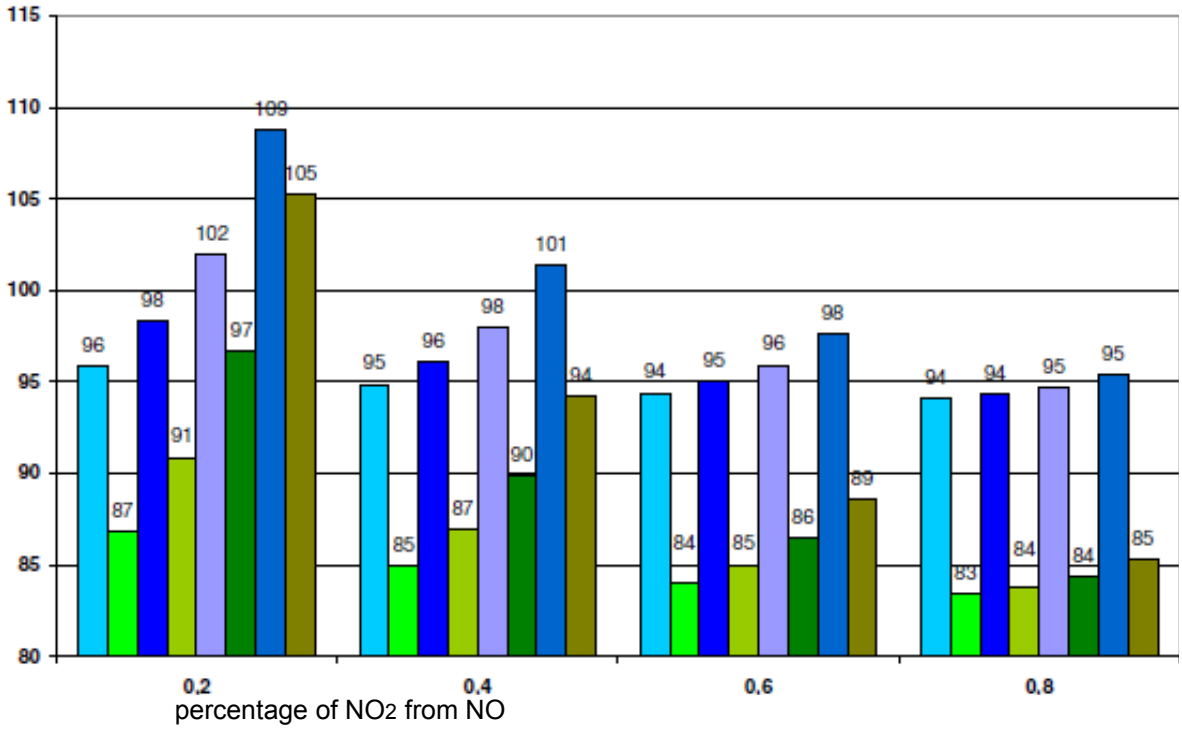
Three factors come into play:

1. Retrofitting diesel cars and light duty vehicles with an oxicat gives a 30% reduction in primary $NO_2$.
2. Retrofitting HDVs without oxicat (originally 8% primary $NO_2$) can stay constant, double to 15%, or increase 5-fold to 40% primary $NO_2$.
3. LEZs reduce total $NO_x$ emissions, due to the replacement of earlier Euro standard vehicles by later Euro standard vehicles.

Statistics on the proportion of different DPFs in use in Germany are not available. However, the DPF retrofit system recommended by Mercedes-Benz (60% of the German heavy goods vehicle (HGV) fleet) is $NO_2$ neutral[44]. This high percentage of Mercedes HGV, together with the retrofitting of light duty vehicles, means that there should be no increase in primary $NO_2$ emissions. This combines with a reduction in $NO_x$ emissions, due to the LEZ of 10% compared with business as usual scenario (BAU), giving a positive impact on $NO_x$ and $NO_2$ emissions.

Reducing $NO_x$ emissions with constant or rising $NO_2$ means reductions in NO. Modelling shows that 40-60% of the total $NO_2$ concentrations are from NO emissions. This impacts on the $NO_2$ concentrations as influenced by the LEZ and retrofitting. This means that the LEZ reduces $NO_2$-impacting emissions by 6-16% compared with a maximum 6% reduction with BAU. As the figure below shows, the LEZ is consistently lower than BAU.

**Figure 36. Total $NO_2$ from both direct $NO_2$ and converted NO in Berlin, compared with 1.1.2008** (in % compared with 2008)




Key:

| |
|---|
| BAU with $NO_2$ neutral DPF |
| LEZ with $NO_2$ neutral DPF |
| BAU with 15% $NO_2$ DPF |
| LEZ with 15% $NO_2$ DPF |
| BAU with 25% $NO_2$ DPF |
| LEZ with 25% $NO_2$ DPF |
| BAU with 40% $NO_2$ DPF |
| LEZ with 40% $NO_2$ DPF |

44 although the impact on city-driving remains to be seen

There is further information in a paper done by Berlin city, a translation of which is available from Lucy Sadler.

### 20.8.2. Dutch study on primary $NO_2$ from DPFs

Dutch studies correlate with this, finding that there was no indication that the average NO2 would increase from retrofitting light duty vehicles (LDVs), and that measurement results rather indicated a decrease of $NO_2$ emission. From 4 sub-studies:

- 4 filters tested by ADAC (German automobile club), all gave constant $NO_x$ and $NO_2$ reduced by 30%
- 4 filters tested by VW, one of the 4 had somewhat higher $NO_2$
- 4 filters tested by UBA (German Environment Agency), filter A had slight decrease at lower load ($NO_2$ from 25% to 25% of $NO_x$), filter B had $NO_2$ decrease for all loads from 40% to 20%, filter C had quite an increase at higher loads (above 275ºC) from 5% to 25%, filter D increase of $NO_2$ at lower loads from 37% to 45%, at higher loads from 15% to 27%.[45].

In Germany, all vehicles are affected by an LEZ. If only heavy-duty vehicles (HDVs) are affected, it would be worth running these calculations for that situation, as the retrofitting of light duty vehicles (LDV) would not counteract the retrofitting of HDVs. The remaining balance would be between the total reduction of $NO_x$ from the LEZ with any increase from retrofitting.

In the Netherlands (where LEZs are HDV-only) they have sought to reduce the numbers of NO2 increasing DPFs fitted by favouring grants towards those DPFs, which do not increase NO2.

### 20.8.3. $NO_2$ urban emissions from Euro V lorries[46]

In the Netherlands and elsewhere, recent measurements have given a better insight into the real world emissions of Euro V lorries in urban traffic conditions. These new estimates of $NO_x$ emissions from lorries using SCR NOx abatement technology in common urban situations are three times higher than the corresponding emission limit, and much higher than estimates based on laboratory or homologation tests. Only at high velocities, such as motorway driving, does the $NO_x$ emission control seem to function well. The results suggest that LEZs (and other cleaner vehicle measures) that encourage replacement of older trucks by Euro V, are less effective than previously thought. However, there is still a substantial positive effect.

It is, in particular, vehicles using SCR that do not function as well in stop-start urban driving. The single lorry tested with an EGR system seems to function better, however, these lorries are less common in the Netherlands. The impact in other countries will depend on the technology split used in the heavy duty vehicles operating in the country's urban areas.

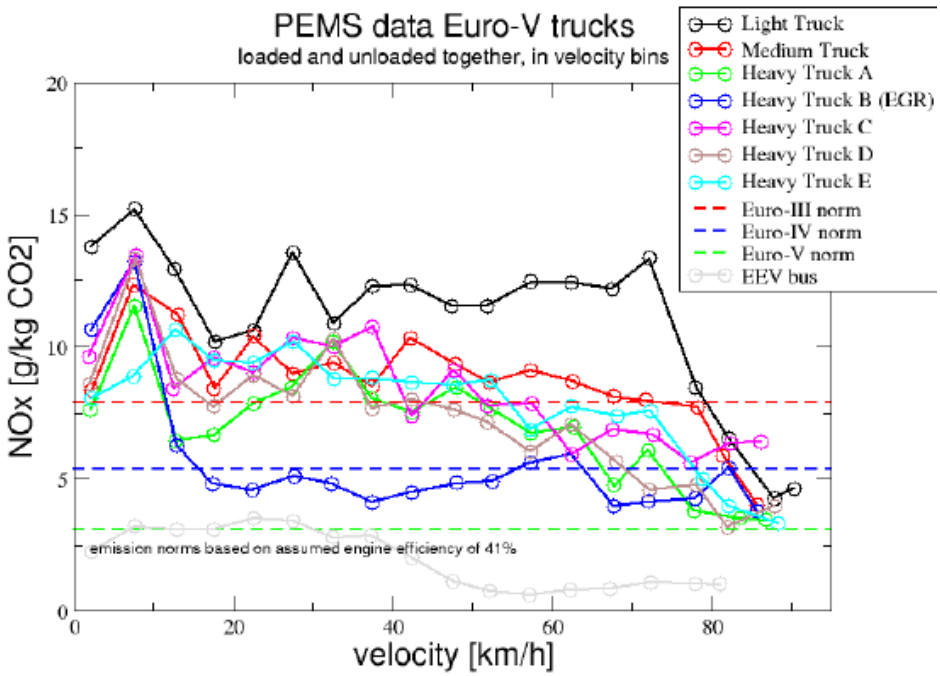
The figure below shows the results found, the different traffic circumstances being roughly distinguished by their velocities. An EEV bus was also measured, as it was suspected to have elevated $NO_2$ emissions due to the DPF fitted. Apart from an observed high fraction of $NO_2$, this bus performs well on $NO_x$ with values on and below the EEV/Euro-V emission standard for $NO_x$. It has to be noted that the bus was not tested on the same reference trip, but on an urban bus route. However, it is not expected that this is a reason for the difference in $NO_x$ emission performance.

Previous 'realworld $NO_x$' emission factors for modern heavy duty vehicles (HDVs) were based on engine tests and stationary-mode chassis tests which are close to the ESC and ETC test procedure. This gave emissions of Euro V trucks only 10-15% higher than the emission standard, as opposed to 300%. The more recent emission measurement programme used a portable emission measurement system (PEMS) to get a direct estimate of real-world $NO_x$ emissions for Euro V lorries. The results, which correspond to other international results, highlight the need for including real-world emissions in the new Euro VI legislation.

45TNO report, Evaluation of particulate filtration efficiency of retrofit dpfs for LDVs

46TNO report, On-road NOx emissions of Euro-V trucks

**Figure 37. Results of the PEMS measurements on Euro V heavy duty vehicles**




As these Euro V lorry results were close to the Euro III emissions factors, Euro III lorries were re-tested to see if there was still a benefit to encouraging Euro V lorries over Euro III. The tests were done at VTT in Finland, with representative driving cycles, vehicles and payloads. The vehicles had diesel particulate filters (DPFs) fitted that would have little effect on $NO_x$ emissions. Table 20 shows the impact this has on emissions factors.

**Table 20. Old and new Dutch emissions factors in terms of the $CO_2$ emission**

| g/kg CO2 | standard | city | motorway | new city | new motorway |
|---|---|---|---|---|---|
| Euro-III | 7.5 | 8-9 | 8-8.5 | 13 | 11 |
| Euro-V | 3.1 | 3.5 | 3-3.5 | 10 | 4 |

This shows that Euro III emissions were previously underestimated for on-road, but less than Euro V were underestimated. Comparing this with the results presented here, it shows that the emissions of Euro III lorries are 20% - 40% higher than previously estimated in the Netherlands. For Euro III the effect of dynamics has been underestimated, which yields a larger effect in urban situations than on the motorway.

In terms of the impact on LEZs from this study, there will be higher $NO_x$ from Euro III and more so for Euro V lorries. However, other elements are also important, such as the primary $NO_2$ emission. Taking into account the decrease in direct $NO_2$ emissions and the increase in $NO_2$ for retrofitted Euro III lorries, the effect for LEZs after 2010 will decrease, but is expected to be a little better than from the reduction of $NO_x$ observed. A preliminary estimate indicates that the impact of this work is to 'around halve' the $NO_x$/ $NO_2$ impact of the Dutch lorry-only LEZs. In such zones, a substantial fraction of Euro III lorries are replaced by Euro V lorries, however, older Euro-I and Euro-II trucks are banned as well. Note: if the vehicle fleet in question has more EGR-Euro V vehicles, then this picture will be different.

## 21. Annex 8. Further details of cost assessments

There are several aspects to the costs of the LEZ, and these are discussed in the sections below. This document includes all LEZ costs that were published before February 2010.

### 21.1. Costs to the authorities for operating LEZs

Costs to operate LEZs are rarely published. Of the examples given here, the Dutch case is more robust than the Danish case, being from experience of 8 cities, rather than one predicted case.

#### 21.1.1. Netherlands

The 2009 MINVROM LEZ monitoring report found that the total spent in preparation of the LEZs by the 8 municipalities involved was up to €1,440,000, with annual running costs (i.e. enforcement) of €600,000.

The costs for an average sized LEZ as in Breda, Den Bosch and Tilburg (population 140-200,000) are around €100,000, larger areas such as Amsterdam may cost a multiple of these. The table below gives the cost outlines for setup specific to the LEZ. If camera enforcement is used, setup is around €10-50,000. As the use of cameras is just starting as of Autumn 2009 (Amsterdam has contracted out 70 cameras, The Hague at EU-tendering stage) costs could not be yet further narrowed down.

Annual manual enforcement costs are around €75,000 per annum per city, excluding the evaluation of the enforcement impact. Other costs may be maintenance of signs and exemptions (which were designed to be cost-neutral).

**Table 21. Dutch local authority costs[47]**

| Description | Cost | Details |
|---|---|---|
| Preparation costs | | |
| Initial research | € 15,000 | Air quality, fleet composition |
| Distribution research | € 30,000 | Ways to optimise distribution and input for calculating economic impact |
| Air quality calculation (often by a consultancy firm) | € 10,000 | Effects on $NO_2$ and $PM_{10}$ concentrations |
| Economic Impact Calculation | € 10,000 | Economic cost to the local economy |
| Internal Supervision of support | 0.5 staff post[48] | Research and co-ordination with stakeholders |
| ***Set-up costs*** | | |
| Communication | € 25,000 | Communication with stakeholders |
| Road signs | € 15,000 | Installation of signs |
| Enforcement setup | € 40,000 | Software & equipment purchase for enforcement & instruction of enforcement officers |
| ***Annual implementation costs*** | | |
| Enforcement | 1 staff post, aprox €60,000 | Enforcement officer and/or police |
| Evaluation (often by a consultanc | € 15,000 | Annual/biannual review of LEZ impact by numberplate monitoring & impact calculation. |

The MINVROM 2008 report gave a more detailed breakdown, and gives a better feel of the range of costs. These costs are given in the table below, taken from the authorities of Utrecht, Eindhoven, Rotterdam, Den Bosch, Breda, Tilburg and The Hague. As the costs are collated from different cities, it is likely that some may have contracted out some aspects of the work, others undertaken the work themselves, depending on the arrangements in that city.

47 Source: Dutch Environment Ministry 2009 LEZ monitoring report

48 In these two tables staff posts were given as FTE=Full Time Equivalent (staff posts)

**Table 22. Costs for Dutch LEZs[49]**

| A. Feasibility Study (½ year) | | Cost |
|---|---|---|
| | Research | €5-25,000 |
| | Air quality investigation | €10-20,000 |
| | Vehicle flows* | €20-30,000 |
| | Project management | €10-30,000 |
| | **Total** | €**100-150,000** |
| | Staff posts required | 1-1.5 staff posts |
| B. Preparation (½ year) | | |
| | Developing exemption policy | €5-20,000 |
| | Setup of hard and software for running the LEZ, such as for exemptions, compliance, penalty notices | €20-30,000 |
| | Developing manual enforcement policies** | €5-10,000 |
| | Purchasing manual enforcement hard/software | €20-40,000 |
| | Road signs | €20-40,000 |
| | Communication*** | €10-100,000 |
| | Project management | €10-30,000 |
| | **Total** | €**75-150,000** |
| | Staff required | 1-1.5 staff posts |
| C. Management (during the LEZ operation)**** | | |
| | Exemptions ongoing project costs / management | €10,000 |
| | Exemptions staff required | 0.5 staff posts |
| | Enforcement by 'competent investigating officer' ongoing project costs | €10,000 |
| | Staff posts required***** | Variable****& |
| | Evaluation/monitoring research costs | €20-30,000 |
| | Overall project costs | €20-40,000 |
| | Total | Not yet available |
| | Staff required | Max 0.5 staff posts + enforcement officers |

* only an exploratory one-off supply study is included.
** Camera enforcement is not included
*** The LA's actions under Communication has varied widely, from handing out leaflets (all), placing adverts (all), briefings (many), placing billboards (Breda), etc
**** Expected for the duration of the scheme, backed up by observations
***** The use of enforcement varies widely. Mostly it is part of their duties anyway, particularly in the morning. Depending on the probability of detection can intensify

#### 21.1.2. Denmark

The public hearing for the public consultation on an LEZ in Odense published estimated costs for the LEZ to the authority. It is manual enforcement.

**Table 23. Costs for the Odense LEZ, paid for by the city**

| **Description** | **Cost** |
|---|---|
| Establishment of LEZ | 500,000 DKK (~€67,000) |
| Operation of LEZ (200 hours at 700 DKK) | 140,000 DKK per annum (~€19,000) |
| Fitting DPFs to LA and fire brigade vehicles | 2,100,000 DKK (~€280,000) |
| Maintenance of above DPFs | 129,000 DKK (~€17,000) |

### 21.2. Who paid for the LEZs?

In general the local authorities (LA) ran the LEZs, and paid for them. There may have been alterations to the LA government/regional grant to allow for air quality work, but this level of detail has not been investigated in this work. The costs here do not include the costs of setting up the national or regional frameworks, which will come on top of these costs, but will reduce the cost to each city.

49 Source: Dutch Environment Ministry 2008 LEZ monitoring report

In terms of where any income from LEZ fines, in Germany[50], the penalties go into the general town funds – but that seems also to be where the enforcement costs come from. In the Netherlands the LEZ fines go to the Treasury, not the towns.

### 21.3. Who paid for the complementary measures?

In general the complementary measures in terms of grants or tax relief have been paid for by national funds. Complimentary measures in terms of improved public transport etc will have been paid for by the local authority. Italy is the exception, where the complementary measures are paid for by the region (but this funding certainly comes from the national funds in at least some cases).

### 21.4. Compliance costs for operators affected by the LEZs

These are presented from various sources. Needless to say this depends on the emissions standards set, vehicles affected and the extent of the LEZ areas.

#### 21.4.1. Denmark

National government estimates before implementation were there will be around 6800 retrofits for the first stage of the LEZs in 2008 and 7200 retrofits for the second stage in 2010, however as of January 2010 only 3 LEZs of the planned 5 had been implemented, so this figure will not have been achieved fully.

In Aarhus, they estimated that 1200 heavy duty vehicles in 2009 and an additional 1000 in 2010 were expected to be affected by the LEZ and require the fitting of a DPF. The total cost is estimated as 97m DKK (€13m). Any costs of replacing vehicles, if vehicle operators chose this compliance option, has not been included, neither has the (reduced) cost of a company altering its fleet operation so compliant vehicles enter LEZs and non-compliant are used elsewhere.

The DPF cost assumptions used in Denmark are 44,000 DKK (€6000) for fitting and 2700 DKK (€360) annual maintenance costs. It should be noted that these costs may well be no longer actual for retrofits undertaken now, and should be revisited before using them in current estimates.

#### 21.4.2. Netherlands

From the 2009 MINVROM LEZ monitoring report the business community has invested €15-€18 million in cleaner vehicles and DPFs. Using a depreciation period of 8 years, the annual costs are €1.9-€2.25 million. These data come from estimating what businesses will do, as there have been no studies assessing actual behaviour of businesses, including exemptions, compliance, fleet re-organisation, sub-contracting etc.

City distribution policies have been introduced in many cities as complementary measures to the LEZ, aiming at more efficient distribution. In most cities plans are under construction with implementation expected for the coming years, with positive effects on transport costs and the environment expected.

The table below shows the number of vehicles per city by businesses type that do not comply with the LEZs. It can be seen that 'itinerant trade' (eg street traders) is particularly high, however, it is precisely the companies in these business groups apply for hardship exemptions, so reduces costs for this group significantly.

**Table 24. Average number of non-compliant vehicles per business group per city[51]**

| Euro standard | Retailers and Catering | Itinerant Trade (eg street traders) |
|---|---|---|
| Euro 0 / 1 | 5 | 20 |
| Euro 2 | 3 | 1 |
| Euro 3 <2002 | 0 | 1 |
| Euro 3 > 2002, no DPF | 1 | 1 |

The average total cost of compliance per city was around €700,000, assuming no exemptions were granted and the operator uses the DPF subsidy. Using the depreciation period of 8 years for these investments, the annual depreciation cost was approximately €90,000. In terms of the different sized Dutch LEZ cities - assuming no exemptions granted (which 7.9% of fleet) and 100% compliance (in

50 Confirmed for Mannheim

51 Data from Sittard, Heerlen and Maastricht

the first half of 2009 this was 80-85%) - the calculated investment for logistics firms and suppliers are:

- €1.5m for Maastricht
- The medium-sized cities Breda, 's-Hertogenbosch, Eindhoven, Heerlen and Tilburg are about €2m per city.
- The profiles of the major cities of Utrecht, Rotterdam and The Hague suggest costs of approximately €3m.
- Amsterdam is estimated as approximately €5m to €8m.

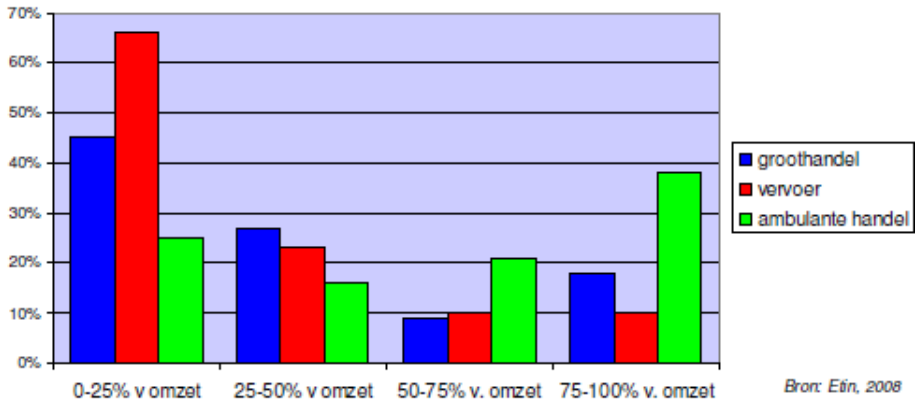
Taking into account the effect of exemptions, the total investment for the 8 LEZ cities is €20-€25m. These figures are further reduced by the fact that many organisations will alter their logistics operation to either ensure that they use their cleaner vehicles in the LEZ or contract out the work to those with cleaner vehicles. This inconvenience will also cost money, but less than replacing or altering the vehicle. The costs of these actions are estimated at €625,000 for the medium-sized cities, and larger cities (Utrecht, Rotterdam and The Hague) around 1.5 times higher, and for Amsterdam yet higher. This gives the delivery cost increase to businesses as €1.5 million per year.

The distribution centres and other complementary measures that are being set up to assist logistics operators will also reduce costs by time savings due to better flowing traffic, increasing the vehicle load factor and pooling deliveries. The improvement schemes will lead to annual distribution cost savings of €200,000-400,000 per city, giving a total over all 8 cities if all the planned measures are implemented of around €1.5m-€3m per annum.

Take-up of the (85%) grants has been extensive, and as of the 9th January 2008, 17,632 HGVs and buses had been retrofitted.

Prior to LEZ implementation, businesses were asked for their estimated expected costs of complying with the LEZ (see figure below). The figures below are overestimates, particularly for market traders. What also suggests that these are overestimates is that the LEZ cities do not receive complaints from specific groups (except street traders) that they are disproportionately affected. In addition, the number of applications under the hardship clause (which prevents businesses experiencing serious financial problems due to the LEZs) is very limited. This illustrates the difference between perception of businesses prior to LEZ implementation and the actual situation.

**Figure 38. Costs estimated by vehicle owners in proportion to turnover.** *NOTE these are overestimates – see above*




Key: blue = wholesale trade, red = transport trade, green = 'market traders'. v omzet = from turnover.

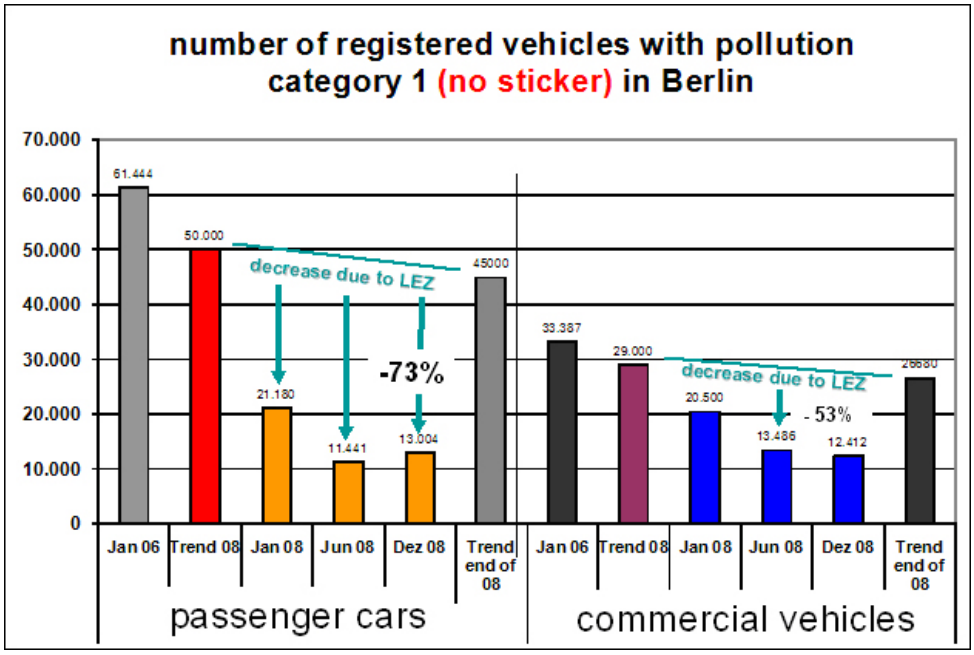
### 21.4.3. Germany

Below gives the number of vehicles affected by the LEZs as given by two cities, these can be used to give a guide to how much compliance has cost. These figures give the numbers of vehicles *registered in that city authority area* that do not comply. The actual number of vehicles affected will be larger, as it is not only these vehicles that wish to enter the LEZ.

#### 1.1.1.1 Berlin

In January 2008 there were 28,800 fewer non-compliant cars registered than would have been expected without the LEZ. In December 2008 this was 32,000 fewer non-compliant cars registered and 14,300 fewer pre-Euro(PM) lorries registered would have been expected without the LEZ.

**Figure 39. Change in pre-Euro 2 diesel and Euro 0 petrol vehicles registered**




The assumptions Berlin made before the implementation about how the vehicle fleet would change to comply are given below:

- Proportion of HGVs >12T retrofitted (also due to Maut[52] incentives) 80%
- Proportion of Euro 3 vehicles retrofitted due to LEZ in 2010 80%
- Fleet change for BAU:
  - Pre-Euro 3 car and goods vehicles (GVs) <7.5T
    -10% per year (2008 & 9) replacement: 20% to Euro 3, 80% to Euro 4
  - Pre-Euro 3 HGVs >7.5T
    -10% per year (2008 & 9) replacement: 20% to Euro 3, 20% to Euro 4, 60% to Euro 5
  - Euro 3 car and GVs <7.5T
    -8% per year (2008 & 9): replacement 100% Euro 4
  - Euro 3 HGVs >7.5T
    -8% per year (2008 & 9): replacement 100% Euro 5
- Fleet change for LEZ with Euro 4 from 1.1.2010:
  - Pre-Euro 4 cars
    2% receive exemptions
    20% to Euro 3 with DPF
    78% to Euro 4
  - Pre- Euro 4 HGVs <12T
    5% receive exemptions
    30% to Euro 3 with DPF
    65% to Euro 4
  - Pre-Euro 4 HGVs >12T
    5% receive exemptions
    30% to Euro 3 with DPF
    65% to Euro

#### 1.1.1.1 Bremen

The total Bremen-registered vehicle fleet in November 2007 is 33,503 vehicles. Of those, 3,778 would not be allowed entry with Euro 3(PM) emissions standard, 8,142 had a Euro 4(PM) standard.

52 Differential motorway toll charge for heavy duty vehicles with a DPF fitted

Note, the vehicle turnover will reduce these figures, the figures do not count vehicles that are registered outside Bremen, but enter Bremen.

Bremen's estimated fleet in 2010 is given in the table below.

**Table 25. Bremen's calculated fleet in 2010**

| Vehicle type | Emissions standard | | % of the emissions type | |
|---|---|---|---|---|
| **Emission** | **Low emission** | **High Emission** | **Low Emission** | **High Emission** |
| **Car** | Euro 3 & better | Euro 2 & less | 91.30% | 8.70% |
| **LGV <3.5T** | Euro 4 & better | Euro 3 & less | 60.40% | 39.60% |
| **HGV 3.5-7.5T** | Euro 4 & better | Euro 3 & less | 38.70% | 61.30% |
| **HGV 7,5-12T** | Euro 4 & better | Euro 3 & less | 43.60% | 56.40% |
| **HGV > 12T** | Euro 5 | Euro 4 & less | 30.60% | 69.40% |

#### 21.4.4. Turin

The winter LEZ in Turin has emissions standards of all private vehicles Euro 1 (petrol and diesel), diesel LGVs Euro 3 during the day/morning respectively. In 2008, there are around are 104,000 vehicles and 50,000 LGVs registered in the Province of Turin that are affected by this measure. This means that in the wider area of the Province of Turin, these vehicles could only enter Turin city centre during the times specified (ie not at peak times). Of these vehicles, around 52,000 cars and 24,700 LGVs are Euro 2 diesel, so able to be retrofitted if the vehicle operator wishes the vehicle to be driven into the centre of Turin.

#### 21.4.5. Sweden

In Stockholm the cost estimates implementation of the LEZ was 37M SEK (approximately €3.4m) and proved to be half as expensive.

### 21.5. More general economic impact

There are other more general economic impacts of LEZs, on which there is some information from the LEZs implemented.

The impact on different sectors has not been addressed in depth by any of the monitoring reports, and addressed in passing by the Dutch reports above. By their nature, LEZs will affect businesses on lower economic margins and those with specialist vehicles. Excessive impacts that would drive businesses out of business can be, and has often, been minimised by exemptions – but care needs to be taken that the impact of the LEZ is not 'exemptioned' away.

The impacts on the economy more generally have also been reported, as outlined below.

#### 21.5.1. Netherlands[53]

Indirect economic benefits:

- Better air quality makes the city a more attractive location for businesses, institutions and citizens. By contrast, urban logistic companies may find it less attractive due to the increased transport costs.
- New developments can now be built again, as they longer result in excess air quality standards. The reason for this is that Dutch law ruled that no new development was allowed where the EU limit values were exceeded, leading to the extensive air quality action plan and LEZs, which enabled development to continue. These projects are in themselves both direct and indirect economic impacts on the local economy.
- Secondary effects of the change in transport logistics processes for suppliers and customers.

53MINVROM 2009 LEZ report

- Improving air quality will reduce the cost of healthcare.

The following businesses are directly affected by the LEZ:

- Suppliers
- Carriers
- Retailers and catering business
- Itinerant Trade (eg street traders)

Three different effects have been studied, however the data available here is of poorer quality than elsewhere, as only three cities had pre-LEZ data.
1. Costs for business due to earlier purchase of cleaner technology
2. Costs for business by disruption of logistics processes.
3. Reduced costs for businesses through improved logistics.

In practice it was found that inner city-based businesses owned few vehicles that did not meet the emissions standards.

Impacts on other issues such as noise, accessibility, safety and $CO_2$ are considered low.

### 21.5.2. Germany

Before the implementation of the LEZ businesses in Berlin warned of 1000's of job losses. Since the implementation no such impact is known, and the tourist board stated that it had also not noticed a negative impact (as of 4th June).

The LEZ had no noticeable impact on business of shops in Mannheim, as confirmed by the Mannheim business community.

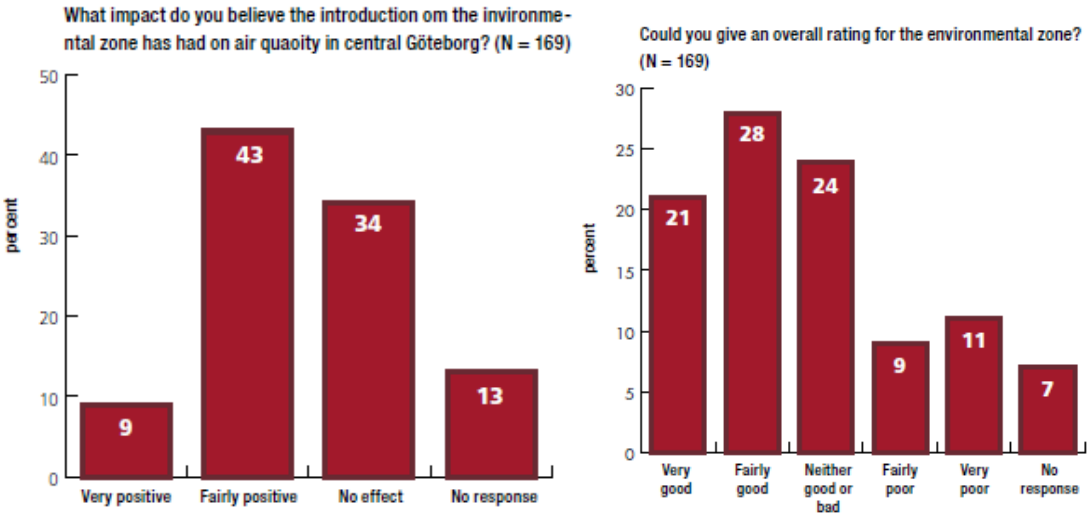
### 21.5.3. Gothenburg

In 2003, Gothenburg surveyed companies' views on the LEZ. Surveys were sent to 440 haulage companies (receiving responses from 136) and 115 of the major suppliers (of which 50 were relevant). A number were followed up with more detailed surveys.

Three quarters of the companies interviewed had heavy goods vehicles (HGVs) that entered the LEZ, 1 on 10 had more than 10 vehicles. Among the suppliers surveyed fewer than half their HGVs entered the LEZ, with lighter lorries often being favoured. While two thirds of the suppliers have light lorries approved for the LEZ, only one third of the haulage companies have such vehicles.

By far the most common type of responses were those concerning the costs of new purchases of vehicles while the prices of second-hand ones had fallen. The positive comments received mainly concerned the LEZs positive effect on the air quality.

**Figure 40. Views of companies on the LEZ**



Suppliers were more positive than the haulage companies. The air quality problems mentioned were mainly that the enforcement is seen as inadequate and that the regulations do not apply to all vehicles. Air pollution from traffic outside the LEZ, boat and passenger traffic were also often mentioned. Despite all the negative comments about costs connected with the introduction of the LEZ, the haulage companies gave a relatively good overall rating to the LEZ. Half of those interviewed gave a rating of very good or fairly good, only ten percent said that the LEZ was very poor. The lowest proportion, giving a very or fairly good rating, were among those who only have one HGV for use within the LEZ.

In Gothenburg many companies work actively to reduce their environmental impact - 86% set environmental requirements for new vehicles. When questioned on other factors concerning haulage in central Gothenburg, over half said there were lots of problems, with 65% of companies wishing more to be done to help streamline road deliveries[54]. Tackling these other issues could be used as part of complimentary measures to support the implementation of an LEZ – as has been done in the Netherlands.

In a separate Gothenburg report for CIVITAS[55] on what can be learnt from their experience. The Swedish LEZs were originally implemented as local measures with co-operation of the 3 major cities, but without national support. Their key learning points are:

- A core implementation group was useful to share experiences and a decision basis, although more should have done to involve vehicle operators.
- A good management team with good leadership from the traffic and public transport authority.
- Having a clear and simple strategy helped.
- The difficulties included:
- A negative attitude among sections of the transport industry's players with objections and delays as a result.
- Lack of active support and participation on the part of the Swedish National Road Administration that cost time and energy.
- In terms of practical and technical problems, the matter of classification and rules and regulations is perhaps the one that has been the most difficult to deal with. Many different interests and competence areas had to be involved in this sub-process. It thus took a long time and ought therefore to have begun very early.
- The way in which permit processing will be organised, the compliance inspections implemented and information conveyed are other substantial areas to formulate. Many ought also to be involved here.
- Investigating and deciding on which vehicle standard and the lack of retrofit technology in the introductory stage.
- Co-operation between Sweden's 3 largest cities enabled success – implementation in just one city would probably not have been possible.
- The goodwill effect was also noted, with the new zone potentially giving an additional argument in favour of choosing Gothenburg.
- Constant contact between the cities was required to ensure that the rules and regulations were similarly implemented. Separate stickers were originally required for each city. There was a feeling that it should be operated by the Swedish National Road Administration to simplify this.

The LEZ affected a number of companies that had not yet undertaken any environmental work. It probably contributed to increased competitiveness and improved profitability for some private

54Assessment of environmental zone in Göteborg, A report for the Traffi c & Public Transport Authority of the City of Göteborg Revised report, May 2006

55 The environmental zone, a world first in Göteborg, An evaluation of the work with the environmental zone, Tommy Gustafsson, Ecoplan, at the request of Hanna Johansson, the Traffic and Public Transport Authority in Göteborg

entrepreneurs. On the other hand, there are examples of entrepreneurs who did not think they had the financial and other necessary resources to adapt to the LEZs requirements and were thereby forced to wind down their operations.