

## Summary

# Low Emission Zones in Europe

## Requirement, enforcement and air quality

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*Many countries are struggling with high levels of particles (PM<sub>10</sub> and PM<sub>2.5</sub>) and nitrogen dioxide (NO<sub>2</sub>), and road traffic is often an important contributor to excess emissions in city areas. Low Emission Zones (LEZ) is a defined area where access for the most polluting vehicles are regulated, either by forbidding the most polluting vehicles to enter the zone, or by demanding a fee for the polluting vehicles to enter or drive in the zone. It is challenging to evaluate the effects of LEZs on air quality, but the measure is used in many cities in Europe. Initially the focus of the LEZs were to reduce particle pollution, and in particular to reduce the emissions from heavy duty vehicles. Today, local vehicle exhaust has a more limited contribution to PM levels in many European cities, and increased focus is given to NO<sub>2</sub> emissions when defining the criteria for the LEZs. Especially diesel vehicles are now targeted and all vehicle types, both light and heavy, are more often included in the regulations.*

## Sweden recently extended their current LEZ regulations

A Low Emission Zone (LEZ) is a defined area where access for the most polluting vehicles is regulated, either by a total ban or a fee. There are now more than 260 LEZs in Europe. Most of the cities who have implemented a LEZ were exceeding the EU's limit values for Particle (PM) and/or Nitrogen Oxide (NO<sub>2</sub>). The first European LEZs were mainly focused on PM, but as many cities also are struggling to meet the NO<sub>2</sub> requirements, this compound is now also targeted in LEZs. Especially the high "real world" NO<sub>2</sub> emissions from diesel vehicle have been in focus. Many cities in Europe are considering to strengthen their existing regulations, while new cities are considering to implement a LEZ.

Sweden was the first European country to implement LEZs. Stockholm, Gothenburg and Malmö implemented their LEZs in 1996. The LEZ regulations in Sweden limited the access of heavy duty vehicles, but the Swedish government has recently made it possible to also include other vehicles in LEZs.

The purpose of this study is to investigate the LEZ regulations in other European cities, and how these regulations are enforced. In addition we are looking into the air quality in Swedish and other LEZ cities, and examining the possible effect on air quality of the LEZ regulations.

## LEZ regulations

If more than one city in a country wants to implement a LEZ, some form of national framework should be in place. This will both ease the implementation process for the city/municipality and make it easier for the vehicle owners to follow the regulations.

Even if there is a national framework for LEZ, it is up to the individual city if they consider LEZ as a good measure to reduce their air pollution problems, and where they want the zone to be.

At the moment not all European countries have a national framework, and the framework which do exist differs from country to country. In a study financed by the European commission (2017), the following recommendations concerning national framework were proposed:

- Developing a system for vehicle requirements. For example developing the sticker-system as used in Germany and France.
- Common list of exemptions, with possibility for some local adaptations.
- Ban versus the possibility for paying a charge.
- If an Automatic Number Plate Recognition (ANPR) will be used, prepare the necessary national databases.
- If retrofitting is allowed, have national standards of how to class different retrofitting technologies.
- National road signs for LEZs.
- Define the day charges to enter the zone and the fines for non-compliance.

Even with a national framework in place some local adaptation, for example concerning possible exemptions should be possible. But it is important that the number of exemptions are held at a minimum, to increase the effectiveness of the regulation.

If possible, increased cooperation between neighbouring countries concerning both information and regulations would be optimal.

## **Camera versus manual control**

The countries studied in this study use either camera surveillance (with ANPR -Automatic Number Plate Recognition) or manual control to enforce the LEZs. Some cities use a combination of the two.

One of the main advantages with camera control, is the possibility to more or less control all vehicles. But, a near 100 per cent detection rate depends on the number of cameras and the positioning of the cameras. London, with a huge LEZ, uses a camera based surveillance system with both fixed and mobile camera units. The fixed cameras are in general situated at the outer border of the LEZ, while the mobile units are used at roads with high traffic volumes within the zone. One disadvantage with the use of camera surveillance with ANPR, is the need to develop several databases and also the different privacy issues.

Manual control will only check a limited sample of the vehicles with access restrictions in the zones. Several cities with manual control of the LEZ regulations had severe problems with both compliance and the amount of (lack of) control activity in the beginning. With increased focus on this, the enforcement has improved. In most cases the police alone will not have the capacity (or will) to prioritize this type of control activity. To improve the compliance, cities with manual control often combine manual control by police with manual control by other regulatory agents. For example, both in Berlin and in Paris the traffic wardens issue a majority of the fines. The police is only responsible for a small percentage of the total amount of fines.

Germany and France both use stickers to make the manual control within the zone easier. This approach is especially advantageous if more than one vehicle type have restrictions.

Table S.1: Some pros and cons with camera versus manual enforcement of LEZ regulations

	Camera surveillance (with ANPR)	Manual control
<b>Pros</b>	<ul style="list-style-type: none"> <li>• Able to control more or less all the vehicles</li> <li>• Good solution especially when a high percentage of the vehicles are included</li> </ul>	<ul style="list-style-type: none"> <li>• Easier to implement</li> <li>• Less privacy issues</li> <li>• Stickers ease the control</li> </ul>
<b>Cons</b>	<ul style="list-style-type: none"> <li>• Can be more expensive and time-consuming to implement, especially if starting from scratch</li> <li>• Need to build up several databases</li> <li>• Privacy issues</li> <li>• Need cameras around and within the zone for maximum detection rate of the internal traffic</li> <li>• Need more cross-border agreement</li> </ul>	<ul style="list-style-type: none"> <li>• Can be difficult to get the police to prioritize</li> <li>• Just a percentage of the vehicles will be checked</li> <li>• Can have high labour costs</li> </ul>

In the LEZs studied in this report, the compliance with regulations is relatively high, and in several cities in the range of 95-98 per cent. The compliance rate will depend on several factors, including: How strict the regulations are, which vehicle types that are included, the number of exemptions, ban versus possibility for period-access, price of period-access passes, the fines, and the perceived and actual risk of detection and the capability to collect fines.

## Effect of LEZ regulations on air quality

What impact a LEZ will have on air quality depends directly on the traffic's contribution to the pollution levels and how efficient the LEZ will change the vehicle fleet composition towards cleaner vehicles, and potentially reduce the total traffic volume. This will then further rely on several factors like the size of the zone and how strict the limitations are.

There are several studies, both modelling and measurements with statistical analysis, which have been performed for LEZs, but the conclusions of the effects varies. The challenges in these evaluations are many, and for instance the use of wrong emission factors for diesel vehicles has been one important challenge for the modelling studies. For air quality measurement studies it is difficult to separate the effect of the LEZ from other measures introduced. This, however does not mean the LEZs did not or will not have an effect. Increased diesel shares in the vehicle fleet and a general increase in number of vehicles and traffic volumes have contributed to more emissions, and hence counterbalanced the emission reduction effect of the LEZs.

There are, however data showing that the zones do alter the vehicle fleet and hence reduce emissions from the targeted vehicle groups. For this to have significant effect on air quality the targeted group needs to be a significant source of the pollution. The non-exhaust contributions from traffic to PM<sub>10</sub> is large, and PM also have several other sources. LEZs is today therefore not expected to have significant effects for this compound except if it so strict that it significantly limits the total traffic volume. LEZs are, however considered to be efficient for NO<sub>2</sub>, CO<sub>2</sub> and other exhaust compounds if targeting a large enough part of the fleet and/or are stringent enough. Several measures are needed to reduce air pollution and LEZs is one of the useful tools at hand for municipalities.

