

REVIEW OF LOW EMISSION ZONES IN EUROPE: CASE OF LONDON AND GERMAN CITIES

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Abstract: Over 72% of population in Europe lives in cities nowadays, using a variety of different transportation vehicles for their intercity mobility. A high density of transportation vehicles in cities is a substantial problem in urban areas, since these vehicles are almost exclusively powered by fossil fuels. Fossil fuels have an impact on human health and emit harmful emissions to the environment when burned. Nevertheless, modern lifestyle is highly dependent on fossil fuels and therefore also highly vulnerable in the case of supply shortfalls. Nowadays, environmental problems and the impact of concentrated transport on human health, especially in cities, gained importance and lead to the detection and greater implementation of alternative technologies and advanced sustainable solutions in the field of environmental protection in cities. Since the EU is heavily dependent on imported fossil fuels and has very small oil reserves and a high share of urban population affected by transport pollutants, it is particularly important for the EU to reduce their impact as efficiently as possible and to implement new solutions for a more sustainable future. One such solution is represented with Green zones - areas where we try to minimize harmful transport related environmental and social impacts such as emissions, noise, smog, particle matter, etc. Therefore, this paper consists of an identification and examination of green zones in the selected EU member states (including UK) with special emphasis on German cities and London and analysis of their pros and cons.

Keywords: environmental impact; green cities; green zones; the EU

1 INTRODUCTION

More than one-half of the world's population now lives in urban areas, but they are blamed for producing as much as 80% of humanity's greenhouse gas emissions. Furthermore, increasing urbanization can negatively impact everything - from the availability of arable land and vital green spaces to potable water and sanitary waste disposal facilities.

Urbanization is one of the major problems in nowadays world. Population shifts from country to urban (city) areas to urban society with its growth that can very rarely be described as environmentally friendly or green [18]. It is predicted that by 2050 about 64% of the developing world and 86% of the developed world will be urbanized. As a result, the percentage of land with green spaces and environmentally friendly neighborhoods begin to decrease rapidly. Moreover, this is followed by factors such as overpopulation, overcrowding, housing problems, trash disposal problems, transport related problems, water supply and sewerage problems, and the problem of urban pollution [12].

A high density of transportation vehicles is also a substantial problem in urban areas, since these vehicles are almost exclusively powered by fossil fuels. Fossil fuels are a mixture of hydrocarbons that impact human health and emit to the environment harmful emissions when burned. In cities, conurbations and near busy roads, particulate emissions often account for clearly over 50% of air pollution. In an effort to protect human health, the EU has passed a European Directive which allows municipalities to establish environmental zones (also green zones) in city centers and conurbations [21]. European Union transport White Paper published in 2011 [5] also stresses the need to develop new transport systems which consume less energy and therefore produce less pollution. The goal of this White Paper is to achieve transport which is more sustainable,

particularly in urban areas where environmental sustainability issues are more severe due to the high concentrations of activities and people [3]. Environmental zones, therefore, enable higher quality of living, less pollution, and smaller risk for human health [13]. Whether such zones are established and when they will become effective depends on the local conditions. It was studied that the most restrictive environmental zones are also most successful in decreasing pollution and increasing the quality of human health [13, 9].

Modern lifestyle is highly dependent on oil and therefore also highly vulnerable in the case of supply shortfalls. Rarity and transience of fossil fuels also lead to the detection and greater implementation of green technologies and advanced sustainable solutions in the field of environmental protection. Since the EU is heavily dependent on fossil fuels and has very small oil reserves, it is particularly important for the EU to reduce the use of fossil fuels as efficiently as possible and to implement innovative systems and solutions for a more sustainable future. One of these solutions is the introduction of green zones. These are the areas where we try to minimize greenhouse gas (GHG) emissions that result particularly from unsustainable transport [16].

Therefore, this paper is dedicated to pointing out the importance of growing environmentally friendly neighborhoods in cities, developing green zones, introducing emission free zones and stopping the greenhouse effect. The purpose of this work is to find out how green zones expansion helps to protect environmental and economic health of a community.

2 GREEN ZONES

If we try to define what a green zone is, we can get very different answers. The definition of a green zone can vary between different communities. However, the common

concept of a green zone is that it provides a local framework to protect the environmental and economic health of a community heavily affected by local pollution [2]. Problems related to urbanization mentioned before in the introduction help to picture green zone as a modern community or community area which is transformed from an economically depressed and highly polluted into sustainable, socially friendly, with new practices of green business, healthier environment, and capable economic future. Green zones can sometimes be defined also only as a green space (etc. a park or a green promenade). Growing appreciation of the role played by green spaces in regulating the local mesoclimate and in the removal of gaseous air pollutants derived from human activities has led many cities to become immersed in a frantic greening process, which has had a direct impact on the citizens' quality of life [1]. In 2010, the Environmental Protection Agency (EPA) confirmed the wide accepted concept of a green zone [2]:

- 1) Well developed regulation and its enforcement to punish responsible polluting industries;
- 2) A community voice in making land-use decisions;
- 3) Land use policies that prevent new pollution projects from locating them in these communities;
- 4) Focused private and public investment in local green development;
- 5) Support for businesses in the green zone that want to "green up" operations;
- 6) Greening these communities by creating more parks, community gardens and urban farms, and developing green businesses and jobs.

Even an entire city may be formed as a green zone. This concept of a green zone connects governmental institutions, society and business to work more effectively by creating communities in which all the stakeholders will have their profit. At the same time, the government could save money from inefficient investments. Nevertheless, the most important factor is that people enjoy living in a safe and healthy society with more new green jobs.

Green zones can be related to the so called "environmental justice", which means that an environment or a zone is healthy and safe, worth to live in, with access to arable land, clean water and air. People see amazing opportunities by themselves. Review of best practices revealed that since the 8th decade of the 19th century the better environment communities have been working on reducing and preventing local pollution in neighborhoods that endangers health and causes unhealthy life. That means that the concept of a green zone is entirely new.

Establishing green zones can have impact on the society where introduced and on municipality (or national) legislation and finances. On the one hand, public support can be gained with promotional events, calculations on emission reduction, and improved air quality. In Ljubljana, the green capital of the EU for 2016, it was stated that black carbon emissions had been reduced for over 70% [8]. On the other hand, financing the green zones can always be problematic in the beginning. However, external and related benefits must also be acknowledged. Wheeland [23] states

that an investment of \$ 1 million in green economy and clean technologies as well as sustainable development schemes generates 16.7 jobs while the same investment in e.g. fossil fuels generates only about 5.3 jobs. In addition to social efficiency, an investment in green zone will reduce health and environmental problems of a city.

One segment of a green or environmental zone is also a low emission zone (LEZ), where air pollution stemming from motor vehicle exhaust is minimized or completely prevented [9], and to which access of most polluting motor vehicles is restricted [3]. LEZs are becoming more and more globally extended, especially in environments where people are aware of negative impacts of personal vehicles on general health and quality of living as well as on the protection of buildings and general infrastructure. A LEZ essentially introduces a step change in the normal fleet turnover, resulting in lower emissions than those that would have occurred without the LEZ. Over time, the fleet emissions will become similar to those that would have occurred without the LEZ. For further benefits, it is necessary to periodically tighten the scheme's criteria [12].

3 METHODOLOGY

To achieve the objective, major tasks have been stated. In this paper, the selected best practices of green zones in the EU have been identified by reviewing special databases and best practices of green zones, emission free zones and traffic restricted zones throughout the EU. Different types of green zone schemes have been identified as well as their importance. Results have been analyzed and discussed. According to the impact, publicity, public acceptance of the selected green zones, time of establishment and data availability, this paper focuses especially on the green zone established in London, as a case of a mega-city green zone, and on green zones in Germany, as a case of a green zone scheme established on a country level.

Another goal was to explore the impacts of green zones on living environment and to identify and analyze core differences between the studied emission free zones in the selected EU member states and cities, where London is still defined as a city within the EU despite Brexit.

At the last stage of the study, by reviewing significant professional and scientific papers and specialized databases all best known green zones within the EU have been identified. These schemes have been analyzed and cross compared to examine what had already been done in existing green zone schemes and what their future plans and improvements are with regard to protecting the environment and create healthy communities. The relation between selected objects is followed by additional comments and proposals for the improvement.

4 LOW EMISSION ZONE IN SELECTED EU MEMBER STATES AND CITIES

4.1 Low emission zone in London

Among others, London has been identified many times as a financial and cultural capital of the world but its air quality is considered to be the worst amongst all the EU member states. London also failed to meet both the EU and the UK standards for air quality in urban areas.

That was one of the reasons why London implemented its first low emission zone in 2008 with a goal to reduce polluting emissions and their harm to society and architecture. Heavy diesel vehicles, buses and coaches were targeted as the most problematic polluters and were addressed in the first phase of the project. Therefore, minimum emission standards were requested for all vehicles operating and covering most of Greater London. Since implementation was phasal, data about its success are not yet sufficient. However, many improvements were identified in recent years, such as the turnover of fleet for problematic vehicle classes. In the second phase (starting in 2012), light commercial vehicles became subject of the low emission vehicle scheme and it also showed similar effect – turnover of a fleet. Despite the growth in freight vehicles

operating in London, the number of pre-Euro 3 vehicles has been decreased and switched from rigid vehicles to light commercial vehicles. Environment air quality increased as particulate matter in London low emission zone decreased by 2.46 to 3.07 % [4].

By now, the low emission zone covers all local roads in Greater London as shown in Fig. 1. Dashed green line shows territory of Greater London which is covered as a low emission zone. Vehicles which do not meet minimum requirements and choose to enter the zone are required to pay a congestion price of £100 for large vans and £200 for heavy vehicles. Another special feature of London is that if the charge is not paid by midnight on the day the vehicle entered the zone, the adjusted penalty fine is five times higher. Central London colored in darker grey has additional £10 congestion charge as it is the most important and most densely populated part of the city with all of the most important institutions and buildings located there. Main roads and motorways which connect Greater London (black and grey lines) also belong to low emission zone scheme. Approximately 150,000 vehicles enter the London low emission zone daily. Out of that 95,000 vehicles are private. Some electric cars have filled up the streets, but their share is still marginal.



Figure 1 Low emission zones in Greater London [4]

Key achievements obtained with implementation of a low emission zone in London are:

- 1) Vehicle fleet change (people buying new produced cars with better environmental performance)
- 2) Downsizing - turnover from heavy to light vehicles;
- 3) Additional 20% drop in pre Euro 3 rigid vehicles in London (in comparison with areas outside LEZ);
- 4) Additional 10% drop in pre Euro 3 LCVs in London (in comparison with areas outside LEZ);
- 5) Air quality changes in the London's LEZ – slight improvement and lacking data measures on air quality.

By 2020, it is planned to turn the entire downtown area into an Ultra – LEZ in which only battery electric and low emission vehicles will be allowed to. The aim of zero emission by 2020 will also be set for all of the city's new taxis. Creating the world's first big-city ultra-low emission zone has the potential to be a changing moment in the quality of life in multimillion cities [15]. The massive use of

bicycles will bring benefits to air quality and encourage people to use new low emission technologies. A combination of restrictions, stimulation and opportunities gives more efficient results in society. One of the priorities that London should focus on when developing ultra-LEZ, is certainly to ensure appropriate infrastructure (e.g. sufficient amount of charging stations for electric vehicles).

4.2 Low emission zones in Germany

Germany established their first LEZs in January of 2008 in Berlin, Cologne and Hanover. Other cities also followed them in the following years. All vehicles entering LEZ no matter whether registered in Germany or abroad need to indicate an environmental badge to enter it. This badge is standardized for all the LEZs in Germany (Green zones n.d.). This stands for the implementation of German law based on the EU Directive 1996/62/EC and 1999/30/EC on ambient air quality and fine particles PM 2.5. In order to

get an environmental badge your vehicle must be registered in and have a certain EURO standard.

Development of EURO standards for diesel and petrol technologies is already used in LEZ and in other countries and cities within the EU. Their development and restrictions are presented in Fig. 2 (Fig. 2a for diesel and Fig. 2b for gasoline technology). It is clearly visible that improvement of gasoline and diesel powered engines in accordance with EURO standards significantly reduces released emissions. The implementation of these standards is also widely accepted and mandatory for car manufacturers. For example, EURO 6 standard is mandatory for all newly produced cars from September 2015. Therefore, LEZ related to EURO standards can be easier to implement and control, since every vehicle EURO standard can be checked. Reduction of older, more environmentally disputable vehicles that cause higher pollution and emissions can be achieved with restrictions related on EURO standards as already implemented in many EU cities.

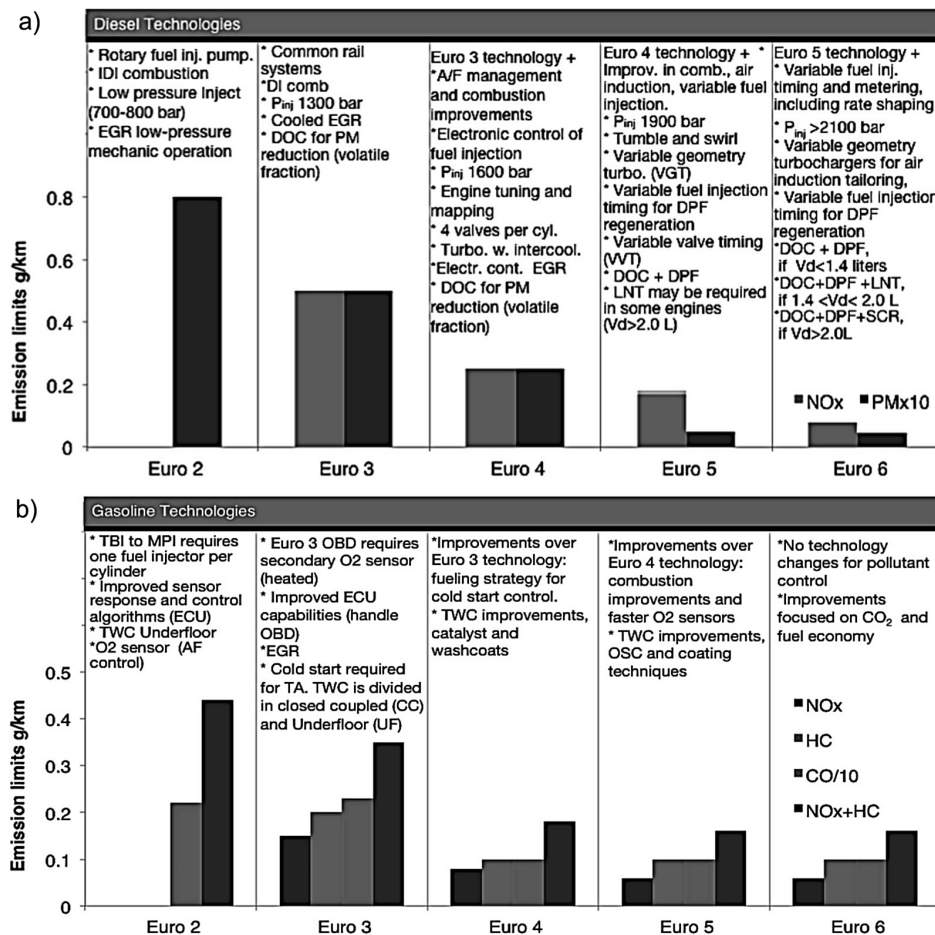


Figure 2 Development of EURO standards for diesel (2a) and gasoline (2b) technologies and their restrictions [20]

LEZ scheme in Germany also offers high quality information about all the Germany's LEZs, restrictions and regulations as well as presentation of prices of badges. This kind of information tool is important for faster implementation of LEZs and for their better acceptance in

the public. Public therefore evaluates this service as user friendly.

Germany's LEZs are segmented in three groups and labelled with special signs on the roads (Green zones EU, 2010) as presented in Fig. 3 (upper right corner).

LEZs started to develop rapidly and efficiently after the failure in 2006, when Germany failed to meet up pollution standards for fine particulates of the EU [19], similarly as in the case of London. Currently, there are three stages of LEZ: Stage 1 LEZ only bans very high-emitting, non-sticker vehicles from entering the zone. Stage 2 LEZ bans non-sticker and red-sticker vehicles. Stage 3 LEZ only grants access to low-emitting vehicles with a green sticker. In all three stages of LEZs, certain exceptions apply, for example for vehicles on medical emergency calls, the police and fire brigades. Vehicle owners who enter LEZ illegally

pay a fine of 80 EUR [13]. Since 2004, many car manufacturers in the EU have focused on revolutionizing the diesel engine by making it cleaner and significantly more fuel efficient so new diesel engines meet the highest emission standards as they have lower CO₂ emissions than gasoline powered vehicles [17].

In Fig. 3, different LEZs in Germany (in 2014) are presented. More than 70 German cities have one kind of a LEZ. Almost all of them are ranked in the environmentally friendly green class. Some crucial findings can be obtained when analyzing Fig. 3.



Figure 3 Low emission zones in Germany [22]

There are significant differences between states. North Rhine-Westphalia and Baden-Württemberg have significantly higher number of established LEZs. Geographically, most of Germany's LEZ are positioned in former West Germany, with exception of Bavaria, with relatively small number of established LEZs or even without them (i.e. Schleswig-Holstein).

The German example proves that LEZ means more than signs on the roads with begging and end and more than just badges and fines. The change from environmentally disputable vehicles powered by fossil fuels to low emission

vehicles makes air cleaner. LEZ also promote combination of walking and cycling instead of driving internal combustion car. The main objective could be defined as to make cities more livable. Integrating green mobility within broader policy of green city development also encourages the use of public transport, which is more environmentally friendly, uses less space and causes less pollution per user than personal vehicle. If the public realized that moving on foot or by bicycles would dominate in future, quality of the journeys could also significantly improve. As a result, the air becomes cleaner and the noise level decreases to a

comfortable level. Government aim is not only to strictly match levels of the EU legislation but also to improve living environment for the society and to implement polluter pay principle (PPP) in practice.

Therefore, information about LEZs is available to everyone and is easy to understand. Funds collected with selling environmental badges and fines will further enhance and enable development of greener cities and development of LEZs (or also designated as green zones) in other cities and geographical areas. Progress can already be seen. Since many cities in Germany turned greener, vehicles that belong to the emission class 3 or lower are not permitted anymore and will therefore be substituted with newer and environmentally friendlier vehicles (environmentally friendlier in the use phase). There is still a dilemma whether this transition is environmentally friendly because old cars really do cause more environmental impacts in the use phase, but are already produced and do not need new materials and energy for their production like new ones. On the other hand, new cars cause less environmental impacts in the use phase but have higher environmental impact as an inevitable consequence of their production. Therefore, we can assume that in some cases life cycle assessment of all environmental impacts of a certain vehicle might actually favor the use of existing ones instead of new ones.

4.3 Comparison of green zones within the EU member states

Restrictions on urban areas transportation can be implemented through access limitations in the form of environmental zones, city tolls, congestion charging, etc. This measures spread rapidly in the recent years throughout the whole EU. Main objective is to establish "green zones" with reduced carbon, noise and light pollution.

However, the EU directives, national legislation and local regulations can differ widely. We have witnessed that local regulations can sometimes be very successful and should be taken into account also when preparing general EU directives on the field of sustainable urban transport planning. The European Commission [6] therefore expressed concerns with respect to an increasingly complex situation in Europe with traffic restrictions through environmental zones in the Green Paper 'Towards a new culture for urban mobility'. It has acknowledged the environmental objectives of these actions. In the Green Paper consultations many stakeholders called for guidance and for development of harmonized and unique rules for green zones within the EU. Standardization of green zones would be appreciated in order to enable a wide use of such measures without creating disproportionate barriers to mobility for citizens and goods especially when coming from another city or a EU member state with different regulation.

Better known green zones in the EU and their restrictions are presented in Tab. 1.

Table 1 Comparison of well-known green zones / low emission zones in the EU [10, 11, 12]

Vehicle Type	LEZ	Current Emissions standard (data for 2014)	Future Emissions standard
Lorries only	Netherlands	Euro 4	-
	Austria (Motorway A12)	Euro 2/3	-
	Austria (Steiermark & Graz)	Euro 3	-
	France/Italy (Mont Blanc Tunnel)	Euro 3	-
	Czech Republic (Prague)	Euro 2	-
	Hungary (Budapest)	Differential parking charges	-
Heavy duty vehicles	United Kingdom (London)	Euro 4 (PM)	-
	Denmark	Fit Filter if less than Euro 4	-
	Sweden	8 years old / Euro 3	-
Vehicles with 4+ wheels	Germany	Euro 3-4 (PM) & Euro 1 Petrol	Euro 4 (PM) & Euro 1 Petrol
	Portugal (Lisbon)	Euro 1 or Euro 2	Planned: Euro 3 all (date not specified)
	Greece (Athens) Netherlands	Euro 1/Euro 4	Utrecht from 1/1/2015. Must be first registered after 1/1/2001
All vehicles	Italy	Euro 1-4 / no 2-stroke motorcycles	Euro 2-4 / no 2-stroke motorcycles
	Slovenia (Maribor)	Euro 0 and Euro 1	Continuing with LEZ if the test phase is successful
Local buses under agreements	United Kingdom (Norwich)	Euro 3 (NOx)	-
	United Kingdom (Oxford and Brighton)	Euro 5	-
Vans	United Kingdom (London)	Euro 3(PM)	-
	Germany	Euro 2-4 (PM) & Euro 1 Petrol	Euro 3-4 (PM) & Euro 1 Petrol
	Italy	Euro 1-4 / no 2-stroke motorcycles	Euro 2-4 / no 2-stroke motorcycle
	Netherlands	-	Utrecht from 1/1/2015. Must be first registered after 1/1/2001

As presented in Tab. 1, different cities across the EU have established different green zones for different types of vehicles. Some of them already have developed long term strategy for further improvement of green zone standards. These future restrictions and standards will become more and more important and will have significant impact also on vehicle demand. It is predicted that green zones will also have positive effect on purchasing electric vehicles, hybrids and other vehicles powered by alternative environmentally friendlier fuels, since conventional vehicles will not be able to enter future green zones. However, it can be tricky that different green zones have different restrictions which are not customer friendly for people traveling between different cities. Therefore, the EU should consider standardized green zone policy framework and unique environmental tag for vehicles.

5 CONCLUSION

Green cities, neighborhoods and zones are being rapidly developed and implemented in many cities across Europe as well as in other continents. Since environmental awareness and energy prices are increasing, demand for green, efficient and rational transportation has increased in last decade. Green cities and green zones within them are becoming essential part of sustainable urban development with great potential for the future.

Further development of green zone research has also been identified. One idea is the monitoring of green zone development within the cities in the EU with regard to their environmental performance. This could represent a tool for improvements on lowering GHG emissions and other environmental impacts caused by unsustainable transport within the cities and would be useful as a model for the development of a larger number of standardized green zones inside the studied area. Tool or index could be primarily developed for the EU but could (with certain modifications) be generally applicable also to other geographical areas. Furthermore, such index would also allow monitoring of progress of a certain city on the field of environmental policy and their benchmarking. This could also be seen as a potential improvement for the monitoring of the efficiency of the EU environmental policies.

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