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Report

Low Emission Zones: Navigating the Social Challenges of Clean Air Policies in EU Cities

Key aspects for policymakers

Institute for European Environmental Policy

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

LIST OF ABBREVIATIONS

BGN	Bulgarian lev (currency)
CNG	Compressed natural gas
CO2	Carbon dioxide
EEA	European Environment Agency
EESI	Equivalent Economic Situation Indicator
EU	European Union
EUR	Euro (currency)
EV	Electric vehicle(s)
GDP	Gross domestic product
IEEP	Institute for European Environmental Policy
LEZ(s)	Low emission zone(s)
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NIMBY	Not in my back yard
NO2	Nitrogen dioxide
O3	Ozone
PLN	Polish złoty (currency)
PM/PM10/PM2.5	Particulate matter
SEK	Swedish krona (currency)
ULEZ	Ultra-low emission zone
WHO	World Health Organization
ZEZ(s)	Zero emission zone(s)

EXECUTIVE SUMMARY

What is the context for this report?

Air pollution is one of the most significant external costs caused by transport, reducing quality of life and causing premature deaths, especially in urban areas. To contribute to the EU's Zero Pollution Action Plan target of reducing by 2030 the number of premature deaths caused by PM2.5 by at least 55% (compared with 2005 levels), the European Commission proposed a revision of the existing Ambient Air Quality Directives. The new Directive will require implementation efforts by Member States, and the proposal notes Low Emission Zones (LEZs) as one potential action[1].

LEZs in cities are gaining considerable attention, due to their potential to limit the access of more polluting vehicles to urban areas, with associated air quality improvements. Whilst many cities in the EU have already implemented LEZs, there are still others where a LEZ could be beneficial but is yet to be realised. The conditions and impacts of LEZs can vary substantially across EU cities due to their diverse contexts, meaning that LEZ implementation needs tailored approaches rather than a one-size-fits-all solution.

What is the aim of this report?

There is growing literature on the environmental benefits of LEZs, but further analysis is needed to investigate how LEZs can be deployed in a socially acceptable way, with support from the local population. This report aims to offer insights into the social impacts and social acceptability of LEZs. It is based on a literature review, together with stakeholder engagement and case studies prepared on LEZs in five EU cities: Brussels, Stockholm, Milan, Sofia and Warsaw. These cities were chosen to represent a variety of geographic and socio-economic characteristics, together with different stages of maturity of LEZ implementation.

What are the key aspects to consider for a LEZ?

The main body of the report discusses the key aspects for consideration when developing and implementing a LEZ, with illustrative real-life examples from the five city case studies.

The **rationale and enabling conditions for introducing a LEZ** need to be considered. The rationale can include the need to address poor air quality and

[1] The new Directive should be finalised by the end of the 2024.

associated health impacts, high levels of car dependence and an ageing car fleet. The national and local policy context, local party-political context and levels of support from citizens, NGOs and other stakeholders can be key enabling conditions.

There are numerous **potential social impacts** which can give rise to either initial resistance or support from different stakeholders. These can include impacts on specific social groups, such as those on lower incomes, large families, people with reduced mobility, residents and businesses. Potential negative impacts include restrictions on vehicle use, costs of purchasing compliant vehicles or using alternative transport, congestion around the periphery of the LEZ, and issues with accessing key services. Positive impacts, in addition to the health and environmental benefits of cleaner air, include new opportunities such as the transition to electric vehicles (EV), business innovations and an increase in vehicle-free open spaces.

There are various **design options** for a LEZ. Access is usually based on vehicle emissions standards (in EU cities, typically the Euro standards) and vehicle type, with restrictions gradually being tightened over time. Other elements include the use of access charges, fines for non-compliant vehicles, and exemptions for specified vehicles or groups of people.

Stakeholder engagement has a vital role to play, both during the development of a LEZ and when planning any changes. This engagement should be done as early as possible, and be as extensive and inclusive as possible of all potentially affected groups. A variety of engagement methods can be used, including written consultations or questionnaires, round tables, citizens' panels and public debates.

Advance planning makes an important contribution to smooth implementation of a LEZ. This involves setting out a clear and transparent timeline specifying future steps and changes to the LEZ and communicating them to affected stakeholders.

It is also vital to ensure **ongoing communication during the implementation** of a LEZ. This ensures citizens and businesses are kept informed of the requirements of the LEZ and any changes. In addition, monitoring the impacts and effectiveness of the LEZ (in particular on air quality) and communicating the results to stakeholders can help to support the case for continuation of the LEZ.

Finally, introducing **complementary measures** alongside the LEZ can help to ensure successful implementation. This must include the provision of clean, affordable and accessible alternative forms of mobility, together with information and advice on their use. Financial support, such as bonuses for reducing private

vehicle use, grants for the purchase of LEZ-compliant vehicles, or cheaper public transport tickets, can also help to ensure fairer implementation, particularly when designed to provide a higher level of support to those groups who need it most.

What recommendations can be given to policymakers?

The report concludes with a final set of recommendations for policymakers looking to implement a LEZ, to ensure that social acceptability is fully taken onboard. These are briefly summarised in the figure below.

Figure 1: Summary of recommendations for policymakers

1. Collect evidence to support LEZ introduction

- Collect and share data on air quality and transport emissions
- Gather information to demonstrate practical benefits to citizens

2. Take into account specific contextual factors

- Draw on national or local air quality plans
- Refer to court rulings or infringement proceedings on air quality
- Identify 'champions' to advocate for a LEZ

3. Identify key groups and the potential impacts

- Identify key groups who may be impacted
- Identify potential impacts – both negative and positive

4. Design the LEZ for fairness

- Take into account key groups and potential impacts
- Consider reasonable but limited specific exemptions to the LEZ
- Design fair compliance mechanisms
- Periodically re-evaluate and adapt LEZ design

5. Consult with stakeholders

- Engage early, often and extensively with stakeholders
- Listen to and act on stakeholders' concerns
- Use a range of appropriate consultation methods

6. Develop a clear and transparent timeline

- Plan significant future implementation steps in advance
- Communicate future steps to citizens and businesses

7. Continue communication efforts during the LEZ's implementation

- Keep existing and new residents informed on current and future LEZ rules
- Use a variety of communication channels
- Provide contact information for concerned citizens

8. Regularly monitor effectiveness of the LEZ

- Monitor levels of key pollutants
- Prepare and publish regularly updated datasets or periodical reports
- Monitor additional impacts (e.g. congestion/traffic flows, health)
- Consider citizen science projects to directly engage citizens

9. Provide and promote alternative mobility options

- Provide clean, accessible and affordable alternatives
- Inform and advise citizens on the alternatives

10. Introduce complementary measures to mitigate social impacts

- Consider other air quality measures (e.g. on domestic heating emissions)
- Invest in EV charging infrastructure
- Connect stakeholders who can benefit from each other's services
- Introduce financial measures (e.g. bonuses, grants, fare reductions)
- Tailor support to those who need it most

1. INTRODUCTION

1.1 Air quality and health impacts in the EU

Among several external costs caused by transport, such as climate change, traffic congestion and road accidents, air pollution is the one analysed most for its health effects (European Commission, Directorate-General for Mobility and Transport, 2019). Air quality affects different aspects of health and livelihoods. According to the European Environment Agency (EEA), air pollution is the largest environmental health risk in Europe so far, as it reduces quality of life and causes premature deaths (European Environment Agency (EEA), 2024; World Health Organization, 2021) (World Health Organization, 2021). Whilst the EU has made some progress in reducing climate-related emissions, exposure to air pollutant concentrations in urban environments still does not meet WHO guidelines (European Environment Agency (EEA), 2024). The burden of poor air quality in the EU is associated with direct and indirect health-related economic costs, which city inhabitants bear in terms of welfare loss and health-related social costs, in some cases consuming up to 8-10% of income earned (Bruyn & Vries, 2020).

Following the goal proposed in the EU's Zero Pollution Action Plan (reducing by 2030 the number of premature deaths caused by PM2.5 by at least 55% compared with 2005 levels), the European Commission announced a proposal to revise the existing Ambient Air Quality Directives (Directives 2004/107/EC and 2008/50/EC) into a single Directive. This was also driven by a fitness check on both Directives, which highlighted four main shortcomings related to air quality standards, monitoring, action plans, and air quality information (European Parliamentary Research Service (EPRS), 2024). A provisional agreement on the Directive was reached in February 2024, approved in March and then formally adopted by the European Parliament in April 2024. While the legislative file is close to being adopted (due by the end of 2024), efforts will be needed at the national level after its transposition, including monitoring of compliance with air quality standards and the development of air quality plans, to improve ambient air quality in areas exceeding pollutant values (Art. 19 of the proposed revised Directive).

1.2 Low-Emission Zones and urban air quality management

Low Emission Zones (LEZs) are specifically mentioned in the Directive's list of potential actions as one measure to limit transport pollution via traffic planning and management[2], even if the proposal does not explicitly encourage cities to

[2] Point B, Point 2 of Annex VIII, COM/2022/542 final.

implement them. Generally speaking, LEZs are considered one of the urban vehicle access regulations that cities can implement to reduce air pollution and traffic congestion (EIT Urban Mobility, 2022). It is worth noting that, whilst air quality standards are set at the EU level, LEZs and other actions needed must be deployed at the Member State, regional, or local/city level. As such, LEZs in cities are gaining considerable attention, due to their potential to limit the access of more polluting vehicles to urban areas and contribute to associated air quality improvements.

Although LEZs are tools to deploy at the local level, there have been calls endorsing substantial support from the EU to local authorities in tackling air pollution, through technical and financial frameworks as well as improving communication on such measures (Lyme, 2023; Mueller, 2023). However, while some harmonisation based on Euro vehicle emissions standards already exists, the conditions and impacts of LEZs can vary substantially across EU cities due to diverse urban contexts. Therefore, LEZ implementation needs tailored approaches rather than a one-size-fits-all solution (Lyme, 2023).

Many cities in the EU have already implemented one or more LEZs, but there are still several others where establishing a LEZ could be beneficial but is yet to be realised (Making Cities Safer, 2020). The trend is clearly positive: in 2019 there were 228 active implemented LEZs; in 2022 the number rose to 320; and projections suggest there may be at least 332 LEZs in 2025 (507 if new national legislations are included) (Clean Cities Campaign, 2022). Besides encouraging a shift to cleaner vehicles, LEZs can generate, in the mid-term, a reduction in commuting and car ownership, with a clear positive effect on urban air quality and the consequent reduction of health-related social costs (Bruyn & Vries, 2020). This can be combined with further positive impacts related to reduced traffic congestion and noise, and positive impacts on local economies (Clean Cities Campaign , 2023).

1.3 Research methodology and scope of the study

While there is growing literature on the environmental benefits of LEZs, additional insights are lacking on their potential socio-economic impacts and overall social acceptability. Besides a well-tailored design and a robust development process, a crucial success factor for LEZ implementation is enhancing social acceptability and how to engage with public resistance. Acceptability is not always straightforward or linear, as demonstrated when the extension of London's Ultra-Low Emission Zone (ULEZ) was perceived as a key factor influencing the result of the July 2023

Uxbridge by-election[3], but the incumbent Mayor of London was later re-elected for a third term in May 2024. As such, further analysis is needed to investigate how LEZs can be deployed in a socially acceptable way, with support from the local population.

As part of its research for the Clean Air Fund contributing to supporting decision-makers to act on air pollution, IEEP has conducted a qualitative analysis of the social impacts and social acceptability of LEZs in five EU cities: Brussels, Stockholm, Milan, Sofia and Warsaw.

The research methodology was structured around two main activities. Firstly, the authors conducted a review of existing literature leading to insights on the social implications of LEZs. This review was instrumental in raising awareness of the current knowledge landscape and identifying gaps in the literature. Secondly, desk-based research was complemented by significant stakeholder engagement, including EU officials, representatives of city networks, officials from the case study cities, civil society experts and academic researchers. The stakeholder insights have been incorporated into the research, providing real-world experiences from across the EU and gathering expert opinions on the social dimension of LEZs.

This approach first created five city case studies, published between June and August 2024, providing concrete evidence of the social impacts associated with LEZ implementation. The present final report draws together the main findings from the literature review, stakeholder engagement and case studies, with a specific focus on the social aspects of LEZs.

The research was also enriched by further considerations raised during IEEP's Think 2030 Conference[4], during which the Just Transition Session shed light on the social acceptability of measures undertaken to tackle climate and environmental concerns.

1.4 Selection of the case study cities

The cities chosen as case studies in this research are characterised by diverse geographic and socio-economic characteristics, as well as different stages of LEZ implementation.

[3] BBC article, July 2023: "Uxbridge by-election: Khan defends Ulez after Starmer blames it for poll setback": https://www.bbc.com/news/uk-politics-66264893

[4] https://think2030.eu/

For instance, Milan is a densely populated city with high traffic congestion and is rated among the most car-dependent towns in Europe (AMAT, 2024). On the contrary, Stockholm has a relatively low population density and is the "oldest" case study, being the first European city to implement a LEZ (Holman, Harrison, and Querol, 2015; Stockholm city, 2022; 2023b). The Brussels-Capital Region can be considered the capital of the EU and is the hub for key EU institutions, agencies and stakeholder representatives, where local clean air policies must be harmonically aligned with the international context.

Sofia is located in Eastern Europe, Warsaw in Central Europe, Stockholm in Northern Europe, Brussels in Western Europe and Milan in the Mediterranean region, providing a sample representative of regional diversity across the EU.

The national and regional legislative frameworks across the five cities are also different, allowing different governance models to be considered.

Moreover, the five cities are at different stages of implementing their LEZs, helping to highlight some of the short-term and long-term impacts. LEZs in Stockholm, Milan, and Brussels are well-established (introduced in 1996, 2008 and 2018 respectively). Sofia and Warsaw are breaking new ground, implementing the first LEZs in Central and Eastern Europe. During the course of the present research, the Warsaw LEZ was not implemented, as it has been officially operational from 1 July 2024.

The case studies also reflect different cultural and historical factors, which can lead to differing perceptions and attitudes towards clean air policies which need to be taken into account when creating a successful LEZ for each city.

Table 1: Summary statistics for 5 case studies

City characteristics					
	Stockholm	**Milan**	**Brussels**	**Sofia**	**Warsaw**
Location in Europe (EU Macro-Regional Strategies)[5]	Baltic Sea Region	Alpine region	None (*de facto* EU capital)	Danube Region	Baltic Sea Region
City area	188 km^2	182 km^2	162 km^2	492 km^2	517 km^2
Population density	5,200 inhabitants per km^2	7,726 inhabitants per km^2	7,528 inhabitants per km^2	2,600 inhabitants per km^2	3,599 inhabitants per km^2
Median age (years old)	39.9	43.3	37.9	40.4	38.9
GDP per inhabitant (% of EU27 average)[6]	171%	130%	196%	45.35%	98%
Unemployment rate	6.4%	6.1%	11.5%	5.0%	1.4%
Gross annual salary (average)	SEK 504,000 (EUR 43,800)	EUR 31,200	EUR 46,632	BGN 20,250 (EUR 10,350)	PLN 115,650 (EUR 24,600)

[5] https://ec.europa.eu/regional_policy/policy/cooperation/macro-regional-strategies_en

[6] This data refers to the regional GDP, at NUTS2 level: https://ec.europa.eu/eurostat/databrowser/view/tgs00006/default/table?lang=en&category=t_na10.t_nama10.t_nama_10reg

LEZ characteristics					
	Stockholm	**Milan**	**Brussels**	**Sofia**	**Warsaw**
Year of LEZ first implementation	1996	2008	2018	2023	2024
LEZ area (% of city)	LEZ1: Approx. 98%	75%	100%	4.2%	7%
Vehicles included	LEZ1: Heavy buses and trucks >3.5 tonnes LEZ2: Older private vehicles, light buses, light trucks ZEZ: All pure electric, gas Euro 6, and fuel cell vehicles. Heavy truck and bus plug-in hybrids (Euro 6) (no other vehicle types)	Area C: All vehicles <7.5m (except motorcycles and mopeds) Area B: Heavy/light buses and trucks, private vehicles <12m (except motorcycles and mopeds)	Cars, vans, (mini)buses and coaches (plus HGVs, mopeds and motorbikes from 1/1/2025)	Passenger vehicles up to 9 seats, goods vehicles up to 3.5 tonnes	Petrol vehicles (including LPG) older than 27 years Diesel vehicles (including LPG) older than 19 years
Current (2024) requirements (emission standards)	LEZ1: Euro 6 LEZ2: Euro 5 (petrol), Euro 6 (diesel) ZEZ: Euro 6 (hybrid only)	Area C: Euro 4 (petrol), Euro 6 (diesel) Area B: Euro 3 (petrol), Euro 6 (diesel)	Euro 2 (petrol), Euro 5 (diesel)	Small ring: roughly equivalent to Euro 3	Euro 2 (petrol), Euro 4 (diesel)
Sanctions and compliance	LEZ1, LEZ2 & ZEZ: SEK 1,000 (EUR 90) fine and risk of vehicle being towed	Area C: EUR 70-285 fine Area B: EUR 163-658 fine and risk of licence suspension	EUR 350 fine	BGN 100-1,000 (EUR 50-500) fine, or BGN 500-2,000 (EUR 255-1,000) property sanction	n.a.

1.5 Structure of this report

The remainder of this report is structured as follows.

Section 2.1 discusses the rationale and enabling conditions for introducing a LEZ; Section 2.2 examines potential social issues to be considered; Section 0 discusses some of the design options for a LEZ; Section 2.4 highlights the role played by stakeholder engagement; Section 2.5 considers the role of advance planning in a LEZ; Section 2.6 discusses the role of ongoing communication when implementing a LEZ; and Section 2.7 provides some examples of complementary measures to ensure an adequate implementation of LEZs.

Finally, Section 3 presents a set of final considerations and recommendations for policymakers, to ensure that social acceptability is fully taken onboard to successfully implement a LEZ.

2. KEY ASPECTS FOR DEVELOPING AND IMPLEMENTING A LEZ

This section of the report discusses some of the key aspects for consideration during the development and implementation of a LEZ, particularly with regard to addressing potential social challenges. It draws on the five city case studies – Stockholm, Milan, Brussels-Capital Region, Warsaw and Sofia – providing real-life examples that can give inspiration to policymakers in other cities on how to develop and implement a LEZ in a way that is as fair and as socially acceptable as possible. The final section of the report then provides some summary recommendations for policymakers.

2.1 Why introduce a LEZ and which conditions can be useful?

A city's decision to introduce a LEZ typically begins from a recognition of the **need to address poor air quality**, especially high levels of particulate matter and NOx/NO_2, in which road transport emissions are usually a major factor. Monitoring of air quality by responsible authorities, citizens' initiatives or academic research can reveal exceedance of national and/or EU air quality limit values. For example, the Regional Court of Sofia ordered the local government to take action to reduce air pollution following a court case brought by citizens in 2021 (Balgaranov, 2021). Meanwhile infringement proceedings launched by the European Commission regarding the Brussels-Capital Region, Italy, Bulgaria and Poland were an important motivating factor for the introduction of the LEZs in Brussels, Milan, Sofia and Warsaw.

In some cities, **high levels of car dependence** and/or an **ageing car fleet** can be indicators that a LEZ may help with air quality improvements, since road transport, and in particular older cars with lower (Euro) emission standards, makes a major contribution to polluting emissions (Antonelli, 2024). This may be particularly relevant in cities with lower GDP per capita (for example the average age of cars in Sofia is 18 years (Lee, Bernard, Dallmann, Braun, & Miller, 2021) and in Poland over 14 years, whilst the European average is below 12 years (Lee K. Y., 2022)).

Data on the adverse health impacts associated with poor air quality can also provide significant motivation to introduce a LEZ. For example, road traffic emissions are estimated to contribute to around 1,000 premature deaths per year in Brussels (Brussels Environment, 2022), residents in Italy's Po Valley are estimated to lose approximately 2-3 years of life due to air pollution (AMAT, 2024), and air pollution in Sofia is estimated to cause 15,000 premature deaths annually and EUR 2.6 billion in associated health costs (Tcolova & Vladimirov,

2023). The introduction of LEZs showed evidence of improving health effects, especially for cardiovascular diseases (Rosemary C Chamberlain, 2023).

The **national and local policy context** can be a key enabling factor. For example, the Brussels-Capital Region has an objective to become climate-neutral by 2050 (Brussels Environment, 2022), the 2015 revision of Bulgaria's Clean Air Law suggested that municipalities could create LEZs to address increased health risks due to air pollution (Food and Agriculture Organization of the United Nations, 2023), and in 2020 the Masovian Voivodeship (the administrative region in which Warsaw sits) adopted a new Air Protection Program foreseeing Warsaw to introduce a LEZ by 2026[7]. Measures such as these can create favourable conditions for the development of a LEZ.

The **local party-political context** can also have a role to play. The presence of a political champion for the introduction of a LEZ, such as the mayor of Milan at the time of introduction of the Ecopass (the city's first version of a LEZ), can help significantly. It is also worth noting that if other conditions are right, political parties of any colour may support a LEZ: in Milan the Ecopass was introduced under a right-wing city government, whereas the Zero Emission Zone (ZEZ) in Stockholm was decided under a green/left coalition.

Finally, **pressure or support from citizens, NGOs and other local stakeholders** can help to create an environment conducive to the introduction of a LEZ. Local air associations and parents' groups in Brussels, the Milan association *MilanosiMuove*, engaged citizens (such as the group *Cittadini per l'aria* (Citizens for Air)), NGOs, and researchers in Sofia, and grassroots pressure from residents, social movements and green NGOs in Warsaw all provided significant support for the introduction of a LEZ. In addition, residents on the fringes of the LEZ in Milan and Warsaw supported the extension of the local LEZ, illustrating that a Not in My Back Yard (NIMBY) attitude to air pollution can lead to citizens advocating for their neighbourhoods to be included in the perimeter of a LEZ.

Depending on the specific context of the city in question, any of these reasons and conditions, particularly if several are combined, may prove useful when deciding to implement a LEZ.

[7] Introduction of the new Air Protection Programme, information available here

Box 1: Examples of positive air quality impacts from LEZ

Since the first LEZ was introduced already in 1996, the **Stockholm** case study offers some insight into the air quality improvements a LEZ can contribute to. Although the LEZ from 1996 is significantly less ambitious than the following two implemented in 2020 and 2024, emissions of PM, hydrocarbon, and nitrogen oxides were reduced by 40, 25, and 10% respectively four years after implementation compared to a scenario without a LEZ. The expected impact of the ZEZ (99% NOx reduction, 90% CO_2 reduction at full compliance) indicates the potential of ZEZs. Further examples of the potential air quality improvements from ZEZs can be found in Williamson, Marner, and Beattie (2022).

The LEZ in **Brussels** has also contributed to substantial air quality improvements. Between 2018 and 2022 (Dehouck, Gerard, Hollander, Goor, & Briffault, 2022), NOx emissions reduced by 31%, black carbon emissions by 62%, PM10 emissions by 19%, and PM2.5 emissions by 30%. By 2023 (Cheymol, 2024), all current EU limit values had been met for NO_2, PM10, PM2.5 and O_3, and the proposed EU limit values for 2030 had already been met for NO_2 (hourly), PM10 (daily and annual), PM2.5 (daily) and O_3 (daily). In addition, the WHO recommended limits had been met for NO_2 (hourly) (although all WHO recommended limits were still exceeded).

2.2 What social issues need to be considered?

Cities looking to introduce a LEZ should be prepared to face some **initial resistance**. Citizens may not be immediately supportive, especially if the LEZ is new and untested. Policymakers willing to take the political risk can begin by providing evidence to build support and counter resistance, for example by highlighting some of the practical benefits of a LEZ, such as reduced traffic, congestion and noise, cleaner air and improved health.

It is worth noting that initial opposition should not be equated with a lack of social acceptance. For example, the opposition from certain political parties to the Stockholm ZEZ has been compared to initial opposition to the previous introduction of congestion taxes, which have now gained broad political support (Stockholm city transport department, 2024). Social acceptability also varies over time, see for example the social acceptance curve as observed for the implementation of congestion charges in Figure 2 (Schack, 2021).

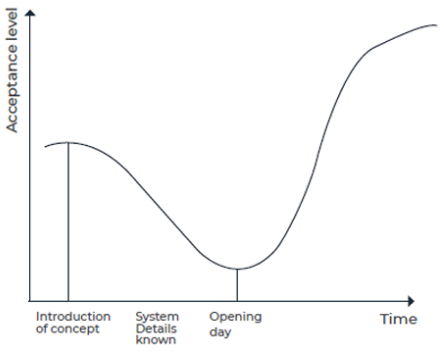

Figure 2: Typical dynamic pattern of acceptance from Schack, 2021.

Importantly, acceptance over time depends on several factors such as perceived effects (positive and negative), costs and benefits, behavioural control and risks, as well as outcome efficacy, social norms, and distributional and procedural fairness, as illustrated in Figure 3 (Morton, 2021; Huijts, Molin, & Steg, 2012; Huijts, Molin, & van Wee, 2014).

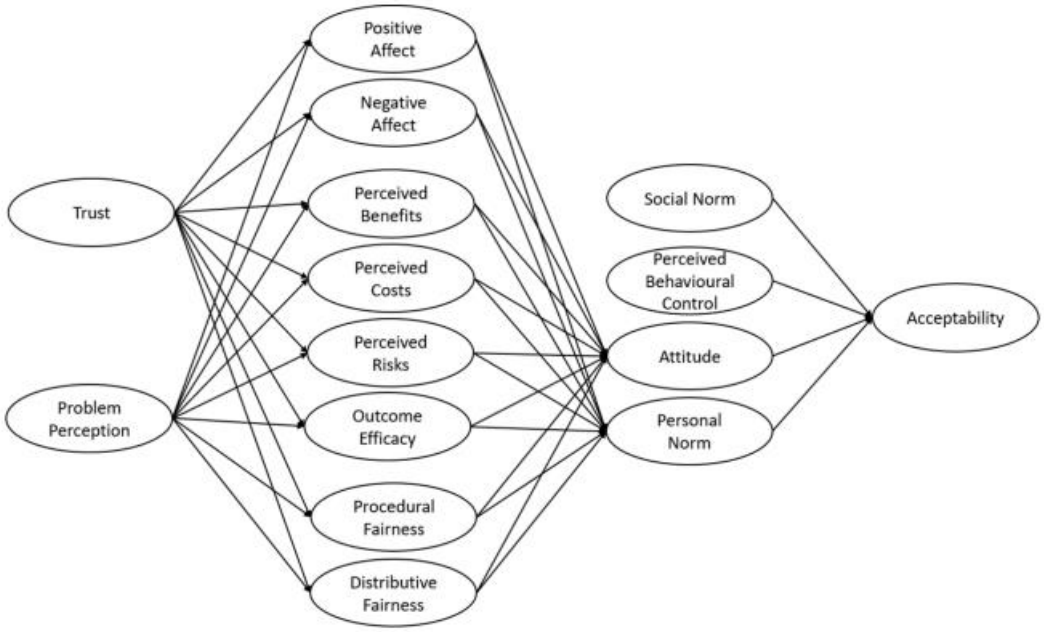

Figure 3: Conceptual framework of acceptability towards sustainable policy from Morton et al. (2021) adapted from Hujits et al. (2012, 2014).

Thus, in addition to making the general case for a LEZ, policymakers must consider various potential negative social impacts, and specific social groups, when developing a LEZ.

LEZs by their nature restrict certain forms of vehicle use, most notably the use of individual private vehicles, especially older and more polluting ones. This can potentially have a **more significant impact on certain social groups**, for example: **those on lower incomes** (who may not be able to afford a newer vehicle that meets the required emission standards)[8]; **large families** (who may face a comparatively higher cost when paying to use alternative mobility modes); **those with reduced mobility**, such as disabled or elderly people (who may have difficulty in using some alternative mobility modes); and **shift-workers** (who may need to travel at times when alternative mobility modes are less readily available).

[8] It is worth noting, however, that in many cases the impacts of air pollution are also more severely felt by poorer households (see e.g. (Clean Cities Campaign , 2023)), meaning that such households stand to benefit from LEZ in other ways.

The LEZ may have an impact around the periphery of the zone, with a possible increase in traffic on roads just outside the LEZ, and of vehicles being parked on the periphery. This can lead to associated impacts on **residents living on the edge of the LEZ** (e.g. increased emissions, congestion and competition for parking). **Residents within the zone** could also be particularly impacted, since they may no longer be able to use their car, or may have to pay each time they use it. Here, a balance is required between outcome efficacy and allowed exemptions (see next section).

Consideration also needs to be given **not to unduly restrict access to certain key services or facilities** within the LEZ, such as hospitals, rail stations, schools and tourist attractions.

In addition, the **potential impacts on businesses** need to be considered. The costs of purchasing LEZ-compliant vehicles can be comparatively higher for smaller businesses, and some companies may rely on entering the LEZ to conduct their trade (e.g. logistics, deliveries, construction, utilities, social and health workers). Businesses within the LEZ may be concerned that access restrictions may reduce their number of customers or otherwise impact on their trade (although the opposite can also be true, with citizens becoming more inclined to travel into the LEZ due to the improved environment, and delivery/logistics improved due to reduced congestion).

These potential negative social impacts can also be **counterbalanced by new opportunities** presented by the implementation of a LEZ. These may include: encouraging the transition to electric vehicles (EV) and associated improved access to EV charging infrastructure; and innovation in new business models (e.g. for logistics, co-loading, shared mobility or rental of compliant vehicles); competitive advantage for businesses who have already electrified their fleet; and an increase in the availability of vehicle-free open spaces.

Box 2: Examples of consideration of social issues

The **Sofia** case study shows the importance of context-specific investigation of social impact of a LEZ. Weather conditions, history and cultural factors, demographics, and purchasing power are examples that may affect the social impact of a LEZ, and what complementary measures are required to counterbalance potential negative impact on vulnerable groups. Moreover, Sofia exemplifies the range of positive impacts of cleaner air, and associated support from potentially unexpected interest groups such as employers in the tech industry having an interest in attracting skilled labour to Sofia.

The investigation from **Stockholm** shows that the positive social impacts in terms of health benefits are particularly prominent for children, young people, pregnant women, elderly, and people with poor health, and in this regard have a positive impact from an equality perspective. For acceptability, it is important to highlight these positive aspects in addition to addressing any adverse impact.

2.3 What are the design options for a LEZ?

Every city is different, with its own local context, so there is no one-size-fits-all approach when it comes to deciding the specific design features of a LEZ.

That said, since the aim of a LEZ is to reduce transport emissions, access to a LEZ is typically based on the **emissions standard/rating of the vehicle**. In EU cities, the Euro vehicle emissions standards[9] (which differ for petrol and diesel vehicles) provide a useful basis for this, since they are standardised across the EU. In all five of our case study cities, the Euro standard of vehicles allowed to enter the LEZ has been and/or will continue to be gradually raised over time, meaning that vehicles with lower emissions are progressively excluded from the zone (see Table 2 below). Pure electric, hydrogen or fuel cell vehicles are frequently exempt since they have zero tailpipe emissions. The approach to hybrid, LPG/LNG and bio-fuel vehicles varies across the case study cities – they are allowed in Milan, subject to the same requirements as their petrol or diesel equivalents in Brussels, and in Stockholm's ZEZ plug-in heavy truck and bus hybrids are allowed, but not hybrid private vehicles, light buses or trucks.

[9] Generally, passenger cars registered after July 1992 should be Euro 1; after January 1996 Euro 2; after January 2000 Euro 3; after January 2005 Euro 4; after September 2009 Euro 5; after September 2014 Euro 6; and after September 2020 Euro 6d. The dates vary for other vehicle types/categories. (Source: https://urbanaccessregulations.eu/low-emission-zones-main/what-emissions-standard-is-my-vehicle#Euro_Standards)

Table 2: Current and future planned minimum Euro standards in the five city case studies

City, zone and fuel type	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Milan Area C (2012) petrol	4	4	4	4	5	5	5	5	5			
Milan Area C (2012) diesel	6	6	6	6	6	6	x	x	x			
Milan Area B (2019) petrol	3	4	4	4	5	5	5	5	5			
Milan Area B (2019) diesel	6	6	6	6	6	6	x	x	x			
Stockholm LEZ1 (1996)	6											
Stockholm LEZ2 (2020) petrol	5											
Stockholm LEZ2 (2020) diesel	6											
Stockholm ZEZ (end 2024), petrol & diesel light vehicles	x	x	x									
Stockholm ZEZ (end 2024), plug-in hybrid heavy trucks & buses	6	6	6									
Brussels (2018) petrol	2	3	3	3	4	4	6	6	6	6	6	x
Brussels (2018) diesel	5	6	6	6	6	6	x	x	x	x	x	x
Sofia small ring (2023)	3	3	3	3	4							
Sofia large ring (2025)	-	1	2	3								
Warsaw (2024) petrol	2	2	3	3	4	4	5	5	6			
Warsaw (2024) diesel	4	4	5	5	6	6	6	6	6			

Notes:
Focus on petrol & diesel cars
Number = Euro standard
All Euro 6 standards (a-e) grouped together
Only Euro standards included (year of manufacture also relevant in some cases)
Standards for Sofia are approximate equivalent to Euro standard
x = vehicle banned
Blank = no info available

Entry to a LEZ is also often dependent on the **vehicle type** (again frequently based on the EU type-approval system[10]), sometimes in combination with the emissions standard. This allows for distinctions between passenger, goods and other vehicles, and between light and heavy vehicles.

Access to a LEZ can be either **free of charge or subject to a fee**. Of our five case study cities, only the Milan Area C LEZ applies an actual charge (EUR 7.50 per entry to the zone), although in Brussels it is possible to purchase up to 24 day passes per non-compliant vehicle per year (regular EUR 35, mopeds/motorbikes EUR 20, HGVs EUR 50 per day). If access is free of charge, there is often **a fine**

[10] Category M: vehicles carrying passengers; Category N: vehicles carrying goods; Category L: 2- and 3-wheel vehicles and quadricycles; Category T: agricultural and forestry tractors and their trailers. Vehicles that belong to category M or N are classified as: light-duty vehicles (passenger cars and vans), or heavy-duty vehicles (trucks, buses, and coaches). (Source: https://single-market-economy.ec.europa.eu/sectors/automotive-industry/vehicle-categories_en)

applied to owners of non-compliant vehicles that enter the zone – this is the case in all the case study cities, except Warsaw.

It is common for a LEZ to have **exemptions for specific types of vehicles**, which may be either automatic or granted after application by the vehicle owner. For example, Stockholm, Milan, Warsaw and Brussels all have exemptions for vehicles used to transport people with disabilities, and Sofia has an exemption for people with a preferential parking card. Emergency and military vehicles are also generally exempt.

The design of a LEZ may also grant **exemptions for certain groups of people**, for example Warsaw exempts people aged 70 by the end of 2023, all Warsaw residents are exempt until the end of 2027, and residents within the Sofia LEZ are also exempt. As noted above, non-compliant vehicle owners in Brussels can purchase a limited number of day passes per year, and in Milan owners of certain vehicles or residents in specific areas are granted a certain number of free accesses to the LEZ. Also in Milan, some polluting vehicles are allowed to travel a limited distance within the Area B LEZ.

Allowing reasonable, limited exemptions such as these can help to increase public acceptability and limit impacts on those who have no viable alternative to private transport, or only occasionally need to enter the LEZ. However, exemptions should be considered in relation to outcome efficacy, so the positive air quality impact of the LEZ is not undermined.

There are also other important design aspects, e.g. the size/geographical area of the LEZ, and compliance/monitoring mechanisms and their associated costs; these are not discussed here but information (where available) can be found in our five city case studies.

Box 3: Examples of LEZ design processes

Once a LEZ is introduced, it is not static but should be updated considering technological, social, and scientific developments. For example, the LEZs in **Stockholm** have been continuously updated with stricter standards since their introduction (Bergeling, 2024).

LEZs can result from ongoing developments in transport policy. For instance, **Milan** first introduced Ecopass, a pollution charge whose primary aim was reducing air pollution, with decreased congestion as a side goal. Since the fleet was renewed over time and more vehicles were entering the restricted area again, public health concerns and doubts about the effectiveness of the Ecopass led to the introduction, thanks to citizens' voices and a referendum, of a proper LEZ (Marchetti & Antonelli, 2024). As such, the LEZ in Milan was the result of progress in transport policies kickstarted by the introduction of a pollution and congestion charge.

In **Brussels**, from the start of 2025 drivers of newly prohibited vehicles will receive a warning for their first entry to the LEZ, rather than a fine; on subsequent entries to the zone they will receive the EUR 350 fine. In addition, payment plans of up to 4 monthly payments can be requested by any individual who finds it difficult to pay the fine.

2.4 What is the role of stakeholder engagement?

Stakeholder consultation and engagement is crucial both **during the development** of a LEZ, and **when planning any changes** to the LEZ. Typically, stakeholder consultation will be more useful and constructive if it is held early, is as extensive as possible, and is done in a detailed and inclusive manner (Clean Cities Campaign , 2023). All potentially affected groups should be reached out to, noting that the loudest voices are not necessarily the most impacted groups, nor representative of the broader population's views. Quality stakeholder engagement allows the various social groups to share their concerns, feel that they are consulted and heard, and – crucially – see that their concerns are acted upon. The key is for the implementing authorities to explain clearly, discuss openly, and listen and take on board the opinions of the consulted groups, both in the initial design and in the ongoing implementation of the LEZ.

Specific groups to engage with include but are not necessarily limited to: those on lower incomes, large families, those with reduced mobility such as disabled or elderly people, residents both within and on the edge of the LEZ, businesses, in particular small businesses, and key services or facilities such as hospitals, rail stations and schools.

Stockholm, Milan, Warsaw and Brussels have all **used different methods to engage with stakeholder groups**, including written questionnaires, round tables, consultation of a citizens' panel, public debates, or even face-to-face meetings with specific businesses or individuals. Some interesting examples from the city case studies are provided below.

Box 4: Examples of approaches to stakeholder engagement

Of key importance is that the outcome of the stakeholder engagement is reflected in the design of the LEZ. In **Sofia**, NGOs raised concern that their views expressed in previous consultations were not reflected in the LEZ proposal. Here, it is important to consider both procedural, recognitional, and distributional justice.

The case of **Stockholm** highlights that detailed and deep stakeholder engagement requires sufficient time and resources. Using different methods for outreach – including surveying a large quantity of citizens, appointing a dedicated employee for stakeholder engagement, and meeting with both umbrella organisations and individual businesses in the area – allowed for a granular view of the problems (for example who believe they will be positively versus negatively affected and in what ways) and solutions (for example by being able to connect actors who could benefit from each other's services).

The **Brussels-Capital Region** government took the political decision in June 2018 to ban diesel vehicles from 2030 and petrol vehicles in a subsequent phase. The government held two phases of stakeholder consultations between September 2018 and April 2019 to support future planning for the LEZ (Brussels Environment, 2019). The first phase involved a written questionnaire sent to around 120 stakeholders (public, private, automotive, academic, energy and associations), with 64 responses received, and the second phase included nine thematic round tables and three focus groups, with around 60 organisations taking part (Brussels Environment, 2019).

2.5 What is the role of advance planning?

When developing a LEZ, it is crucial for the implementing authority to set out a **clear and transparent timeline specifying future steps** as far in advance as possible. This allows citizens and businesses to know what to expect and when, for example in terms of future restrictions, giving them greater certainty to plan ahead, for example by making investments in newer vehicles or preparing to use alternative mobility options. It can also encourage 'pre-compliance', such as businesses replacing affected vehicles in their fleet before new restrictions are introduced, thereby promoting smoother implementation when the changes enter into force. As with any other aspect of a LEZ, future steps should be

discussed with stakeholders, to assess any new or different potential impacts and allow for accompanying adjustments to be made.

Box 5: Examples of forward planning in LEZs

In **Brussels**, the future schedule for the LEZ, indicating which Euro emission standards will become excluded from the zone in which year, is already planned through to 2035, when many petrol/LPG/CNG vehicles will be banned (with many diesel vehicles already being banned from 2030), effectively creating a zero-emission zone (ZEZ). This schedule is publicly available online[11], together with a tool where vehicle owners can enter their vehicle details to see if they are permitted to enter the LEZ[12].

In **Warsaw**, the LEZ will be implemented in 5 stages from 2024 for eight years, with tightening of vehicle access until 2032. Each phase progressively excludes access for older and more polluting vehicles, with all vehicles meeting at least Euro 6 standards by 2032. The LEZ project introduces exemptions for residents, who will have four years to adapt to its requirements.

2.6 What is the role of communication during implementation?

It is also critical to **continue communication efforts throughout the ongoing implementation** of the LEZ. A LEZ will often change over time, for example with the introduction of restrictions for additional vehicle types, the exclusion of vehicles with higher Euro emission standards, changes in the area/size of the zone, or changes in fees for entering the zone. In addition, the population of cities continually changes, with people moving in or out of the city or the area of the LEZ, meaning that some citizens may not be aware of the LEZ rules if communication efforts stop at the time of the zone's introduction. Ongoing communication with citizens and businesses, in particular when there are upcoming changes, is therefore essential. Information should be readily available and accessible to all through dedicated spaces and platforms. Using communication channels is crucial to ensure that everyone is effectively reached (Clean Cities Campaign , 2023).

Complementary communication efforts on issues not related simply to the operation of the LEZ, can also be helpful in maintaining stakeholder acceptance. For example, monitoring and communication of the air quality impacts of the LEZ through regular reporting (in the case of Milan), or even citizen science projects (such as the *CurieuzenAir* initiative in Brussels that directly involved the public in

[11] See: https://www.lez.brussels/mytax/en/practical?tab=Agenda
[12] See: https://www.lez.brussels/mytax/en/automatic-simulation

air quality monitoring) can help to demonstrate the benefits and enhance support for the LEZ. In our five city case studies, we found very limited evidence of monitoring of health or other social impacts (e.g. on income or access to services for specific social groups). This suggests that the monitoring and communication of social impacts is an area which can be improved upon even in long-established LEZ. Putting such monitoring and communication in place from the introduction of a LEZ would enable the gathering of data that could be very useful in making the case for continuation of the LEZ, but also for the introduction of LEZs in other EU cities.

Box 6: Examples of continuing communication around a LEZ

In **Brussels**, there are continuous communication efforts around the LEZ (Dehouck, Gerard, Hollander, Goor, & Briffault, 2022). For example in 2022, information letters were sent to all car-owners affected by the upcoming ban on Euro 4 vehicles (Gérard, 2024), and from May to December 2024 the new requirements for 2025 will be publicised via an email to stakeholders and a communication kit sent to the press, together with further promotion of *Mobility Coach* and the *Bruxell'Air bonus* (Brussels Environment, 2024). (See Section 2.7 for further information on these initiatives).

Also in **Brussels**, the one month-long citizen science *CurieuzenAir* project in 2021 (CurieuzenAir, 2022) gave 3,000 citizens tubes to place on their homes to measure NO2 levels, revealing significant air quality differences between socio-economically vulnerable neighbourhoods and richer, greener ones. The project cost around EUR 300,000 and significantly raised citizens' awareness of air quality issues (Sevino, 2024). Another project in 2020 used remote-sensing to measure the real emissions of vehicles in 8 Brussels locations (Brussels Environment, 2023), with the results helping to demonstrate to citizens the importance of stricter LEZ limits for 2022 and 2025 (Gérard, 2024).

Relatedly, in **Stockholm**, the need to use different channels of communication to reach different social groups was recognised. Communication channels used include radio, local newspapers, the city website, information boards, social media, direct contact with city employees, emails, post, and signs.

In **Warsaw**, the City Council engaged with citizens through online forms, online meetings, consultation points and working groups, where participants could exchange insights and observations, and experts and representatives of the Traffic management office answered questions. While the main objective was to collect opinions on LEZ implementation, the process was also used to enhance citizens' understanding of transportation and communication on LEZ.

2.7 What complementary and supporting measures can accompany a LEZ?

As noted above, LEZs are a good tool to contribute to reduced transport emissions, congestion and noise, and associated improved health outcomes. However, they also place restrictions on transport options for citizens and businesses, and can potentially have impacts on different social groups if introduced in isolation. It is therefore important to consider introducing **complementary and supporting measures** alongside a LEZ, to address some of these impacts (Sandra Wappelhorst, 2023).

If private vehicle transport is restricted, it is vital to ensure the **provision and promotion of alternative forms of mobility**. These should be clean, accessible and affordable, so they support the air quality objectives of the LEZ whilst also providing mobility to all those who need it. Stockholm, Milan and Brussels have all improved alternatives, including public transport, bike- and car-sharing, additional pedestrian areas and cycle lanes, or additional EV charging infrastructure. Cities should also provide citizens with **information and advice** on these alternatives, to demonstrate how they can be used to maintain or even improve citizens' mobility and encourage their uptake.

In addition, offering **financial support** to certain groups can help to ensure fairer implementation of an LEZ. This can include a range of different financial support for both citizens and businesses, for example: financial bonuses for reducing private vehicle use; free or cheaper public transport tickets; grants to be spent on alternative mobility options; free or discounted attractions in the city (theatres, cinemas, sports activities); grants or loans for the purchase of lower-emission vehicles; or free parking at the periphery of the LEZ (Wappelhorst, Bui, & Morrison, 2023).

Some specific examples of accompanying measures from our case study cities are provided below.

Box 7: Examples of complementary measures to accompany LEZs

Outcome efficacy is one important factor for acceptability. Thus, it is important that the LEZ is implemented with a holistic understanding of the sources of air pollution. In the case of **Sofia,** this meant implementing the LEZ for traffic in combination with a LEZ for domestic heating (recognising its important contribution to air pollution), tackling multiple pollution sources simultaneously.

In **Milan**, implementing the "Area B" LEZ involved incentives to businesses and citizens with an EESI (Equivalent Economic Situation Indicator) income less than or equal to EUR 20,000, to foster the purchase of less polluting vehicles. Additionally from 2019 to 2022, the municipality provided public contributions of up to EUR 27 million to allow low-income households to purchase less-polluting vehicles (Marchetti & Antonelli, 2024).

The **Brussels** LEZ is accompanied by several complementary measures. The *Bruxell'Air bonus*, introduced in 2006 was relaunched in 2022. The bonus is given to Brussels residents who deregister their car: EUR 1,010 for lower income households, EUR 705 for middle incomes, and EUR 505 for higher incomes. Recipients have 2 years to spend it on mobility related purchases such as public transport, cycling or car sharing. From 2022 until the end of May 2024, 3,969 bonuses were awarded, 59% to lower income households, 26% to middle incomes, 11% to higher incomes, and 4% to households including a disabled person (Gérard, 2024).

The *Mobility Coach* campaign provides free advice to citizens on sustainable mobility options, including mobility tests to trial electric bicycles and mobility visits to discuss different alternatives. In 2022 and 2023, a total of 1,518 advice requests were dealt with, along with 39 mobility tests and 19 mobility visits. (Dehouck, Gerard, Hollander, Goor, & Briffault, 2022) (Gérard, 2024).

Low-emission mobility allowances are available to micro, small and medium enterprises. They can receive up to 3 grants per year to replace non-LEZ compliant vehicles, for between 5 and 40% of the purchase price, and with higher maximum grants for micro & small enterprises. Up to 3 grants per year are also available for 40-70% of the purchase price of a cargo bike or bike trailer. In 2022, 16 grants were awarded with a total value of EUR 143,311, to 11 micro and 5 small enterprises (Dehouck, Gerard, Hollander, Goor, & Briffault, 2022).

The *Electrify.brussels* plan, launched in 2022, aims to install 22,000 public EV charging points by 2035, ensuring one within 150m of every household in Brussels by 2024. EUR 500,000 of funding was provided by Brussels Environment in both 2022 and 2023, to support the installation of 203 new recharging points (Brussels Environment, 2023a).

3. RECOMMENDATIONS FOR POLICYMAKERS

Every European country, region, and city has different contextual circumstances, meaning there is no one-size-fits-all approach when it comes to implementing a LEZ. However, some shared lessons from our five city case studies offer valuable insights that can be useful in various contexts. This final section summarises the main lessons in a set of recommendations aimed at helping policymakers to consider potential social impacts and social acceptability issues when deciding to introduce a LEZ, and throughout its implementation.

1. Collect evidence to support LEZ introduction

▶ Collect and share data on air quality and transport emissions
▶ Gather information to demonstrate practical benefits to citizens

Local policymakers may face some initial resistance to introducing a LEZ in their city, with citizens not always immediately supporting something new to them. However, if policymakers can explain and demonstrate the practical benefits to citizens, in particular by collecting and sharing robust data on air quality, the contribution of transport to air pollution, and the associated health impacts, this can help to build a case for introducing a LEZ.

2. Take into account specific contextual factors

▶ Draw on national or local air quality plans
▶ Refer to court rulings or infringement proceedings on air quality
▶ Identify 'champions' to advocate for a LEZ

Elements of a city's specific policy and political context may also help enable the introduction of a LEZ. For example, national or local air quality plans, or court rulings or infringement proceedings (European, national or local), may provide a solid foundation for measures to improve air quality. It is also useful to have one or more 'champions' to advocate for a LEZ – a city mayor, political party, academics, health professionals or any number of local associations or NGOs can help to make the case and build consensus with other stakeholders.

3. Identify key groups and the potential impacts

▶ Identify key groups who may be impacted
▶ Identify potential impacts – both negative and positive

Before implementing a LEZ, policymakers should make efforts to identify the key groups and the potential impacts on them, so they can be comprehensively accounted for.

Impacted groups may include, but not be limited to, lower-income households, large families, those with reduced mobility (e.g. disabled or elderly people), shift-workers, residents on the edge of and within the LEZ, and businesses operating within the LEZ.

Potential negative impacts may include vehicle use restrictions, financial costs (e.g. of purchasing a compliant vehicle or using alternative mobility), difficulty in accessing key services (e.g. hospitals, rail stations, schools), emissions and congestion around the LEZ periphery, and reduction in trade for businesses. Potential positive impacts (in addition to improved air quality and related health and environmental benefits) should also be considered for a more comprehensive understanding – these may include promoting the transition to electric vehicles, innovation in new business models, increased trade for business within the zone, advantages for innovative and front-runner businesses (e.g. those who electrify their fleet early), and more vehicle-free open spaces.

 **4. Design the LEZ for fairness** ▶ Take into account key groups and potential impacts ▶ Consider reasonable but limited specific exemptions to the LEZ ▶ Design fair compliance mechanisms ▶ Periodically re-evaluate and adapt LEZ design	A clear mapping of the potential affected groups and impacts will help with designing the LEZ in as fair a way as possible, ensuring negative impacts are minimised and positive impacts maximised. Allowing reasonable but limited specific exemptions to the zone, such as transport for disabled people, or access on a limited number of days for non-compliant vehicles or residents, can help to increase its acceptability. Drivers of non-compliant vehicles can be issued with a warning rather than a fine for their first offence, and delayed or instalment payment plans can be provided for individuals who find it difficult to pay a fine. In addition, the design of LEZs should be re-evaluated periodically to allow for changes that recognise their unforeseen impacts (both positive and negative) as well as technological, social and scientific developments.
 **5. Consult with stakeholders** ▶ Engage early, often and extensively with stakeholders ▶ Listen to and act on stakeholders' concerns ▶ Use a range of appropriate consultation methods	Stakeholder consultation and engagement is crucial, both during the development of a LEZ, and also when planning any changes. This will help to create trust between citizens and policymakers, and legitimacy of the project among citizens. Early consultation with a wide range of stakeholders is crucial to ensure that their concerns are heard and can be considered in the design of the LEZ. Additional consultations should be held in the context of planning for future changes to the LEZ. A wide range of consultation methods can be used, depending on what is most appropriate in the local context or for the stakeholder groups to be reached. This can include options such as written questionnaires, online, email or telephone feedback options, roundtables, citizens' panels, public debates, or individual face-to-face meetings.

 **6. Develop a clear and transparent timeline** ▶ Plan significant future implementation steps in advance ▶ Communicate future steps to citizens and businesses	It is usually possible to plan significant future steps in a LEZ's implementation in advance, for example, the progressive inclusion of different vehicle types or Euro emission standards. Planning and communicating these steps in advance provides predictability for businesses and citizens, allowing them to shift their behaviour and prepare in advance, and can also encourage 'pre-compliance' such as getting rid of affected vehicles before new restrictions are introduced.
 **7. Continue communication efforts during the LEZ's implementation** ▶ Keep existing and new residents informed on current and future LEZ rules ▶ Use a variety of communication channels ▶ Provide contact information for concerned citizens	The city authorities should continue their communication efforts during the implementation of the LEZ. This can be particularly helpful when there are upcoming changes, but is also necessary simply to ensure that residents are kept informed on the LEZ's rules since the population of cities continually changes. Communication should be conducted through a wide range of channels (e.g. post, TV, radio, print media, social media) to ensure the widest possible reach. Providing contact information will allow citizens to ask for more information or raise concerns.
 **8. Regularly monitor effectiveness of the LEZ** ▶ Monitor levels of key pollutants ▶ Prepare and publish regularly updated datasets or periodical reports ▶ Monitor additional impacts (e.g. congestion/traffic flows, health) ▶ Consider citizen science projects to directly engage citizens	Once a LEZ is in effect, it is important to monitor its effectiveness, both to enhance acceptability and to inform future implementation decisions. Since LEZs mainly aim to improve air quality, the levels of key pollutants should be a core focus of this monitoring. Such monitoring can be helpful in supporting the case for continuation of the LEZ. This is particularly true if it is used to prepare regularly updated datasets or periodical reports that are published, for example online. Citizen science projects can also be considered to demonstrate the tangible benefits for citizens. Additional metrics can also be monitored, for example on congestion/traffic flows, and health.

9. Provide and promote alternative mobility options

▶ Provide clean, accessible and affordable alternatives
▶ Inform and advise citizens on the alternatives

When placing restrictions on transport by limiting the access of certain vehicles to a city, it is vital to ensure the provision and promotion of alternative forms of mobility so that overall freedom of movement is not restricted. Alternatives should be clean, accessible and affordable, so they support the air quality objectives of the LEZ whilst also providing mobility to all those who need it. Alternatives may include improved public transport provision, bike- and car-sharing and increased electric vehicle charging infrastructure. Cities should provide citizens with information on these alternatives, for example through advertising or promotional campaigns, targeted advice sessions or free trials of alternatives.

10. Introduce complementary measures to mitigate social impacts

▶ Consider other air quality measures (e.g. on domestic heating emissions)
▶ Invest in EV charging infrastructure
▶ Connect stakeholders who can benefit from each other's services
▶ Introduce financial measures (e.g. bonuses, grants, fare reductions)
▶ Tailor support to those who need it most

Finally, introducing complementary measures alongside a LEZ can help to ensure more effective and fairer implementation. In addition to communicating and providing advice on alternative forms of mobility, options include complementary simultaneous measures to improve air quality (such as steps to reduce emissions from domestic heating), improvements in EV infrastructure (since EVs are typically permitted in LEZs) or helping to connect stakeholders who can benefit from each other's services (e.g. low-emission logistics companies and businesses within the LEZ).

Financial measures should also be considered, such as bonuses for citizens who permanently give up their private car, grants for citizens and businesses to purchase low-emission vehicles, or free or cheaper public transport tickets. Financial support should be designed with equity in mind, for example by providing a higher level of support to lower-income households and SMEs.

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