POLICY BRIEF

LOW EMISSION ZONES IN INDIAN CITIES

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Authors: Anumita Roychowdhury, Anannya Das and Meshak Bandela

Research support: Dipanjan Nag

Cover: Ajit Bajaj

Production: Rakesh Shrivastava and Gundhar Das

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41, Tughlakabad Institutional Area
New Delhi 110 062
Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: sales@cseinida.org
Website: www.cseindia.org

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Spotlight: Towards low emission zones in cities

Globally, area based approach to regulating mobility and vehicle movement in targeted zones in cities is gaining credence and popularity to combat air pollution and decarbonize transport climate change. These initiatives are designed to meet a broad set of objectives: — mitigate emissions and carbon intensity of transport; accelerate carbon neutral mobility, clean vehicles and zero emission battery operated electric vehicles (ZEV); combat traffic congestion; promote accessibility, safe movement of all and improve livability and equity. All of these together are expected to reduce healthcare costs and increase productivity.

Broadly, low emission zones (LEZs) are areas demarcated within cities or regions where access is restricted either through physical restrictions or through differential pricing based on emission levels of vehicles.

There is growing interest in India to implement such a strategy to speed up climate and clean air action. The primary driver is the growing local air pollution, especially toxic particulate pollution and also nitrogen oxides (NOx) that come largely from vehicles. There is considerable opportunity in its potential applications in polluted cities of India. Under the National Clean Air Programme (NCAP) about 132 non-attainment cities are implementing clean air action plans to reduce particulate pollution by 2030 per cent by 2024 and 40-45 per cent by 2026. Some of them have started to build on the provision of public transport, walking and cycling and vehicle restraint measures to frame their low emission zones approach.

This is an opportunity that needs to be leveraged to strengthen city based action on transportation and mobility and integrate LEZ approach to maximise emissions and welfare gains. However, the concept of LEZ is still very nascent in India. Even though the conversation has started and there are small efforts to pedestrianise small stretches or regulate movement of vehicles, there is no working model on ground that meets the benchmarks for LEZ applications.

Yet, given the growing policy interest in big cities like Delhi or in smaller capital cities like Bhubaneswar it has become necessary to evaluate the scope of its application and understand the prerequisites to taking a step towards LEZ implementation.

It is from this perspective that this Policy Brief assesses the scope of its implementation, identifies the key elements from the global practices and explores what is needed at the city level to enable its implementation. This has also carried out conversation with the concerned departments in cities. Special effort has been made to carry out a stakeholder mapping and engagement in the capital city of Bhubaneswar in Odisha that has taken the lead to include LEZ approach in their clean air action plan.

It may be noted that globally, the LEZ approach is largely defined to regulate vehicle movement to reduce vehicular emissions. This does not include all other pollution sources in the designated zones. While this can continue to be the driver even in Indian cities, there might be a more holistic interest in developing low emission zones by addressing a range of local pollution in pollution hotspots. In fact, Bhubaneswar is likely to take that expanded approach. It is too early to predict the pathways of this evolving concept in Indian cities.

In view of the fact that most non-attainment cities have already adopted hotspot pollution planning approaches to address a wide ranging source of pollution in a given area, this policy brief will focus on the specific linkage between LEZ and vehicular pollution. This is primarily because the review of the current hotspot plans show very limited impact on the vehicular pollution control strategies. More explicit and focused LEZ approach is needed to promote sustainable modes of transport, clean and zero emission vehicles to address the challenge.

This policy brief is divided into two parts: i) the overview learning from the global experience and ii) the perception of the key regulatory and implementation agencies in Bhubaneswar on the regulatory, legal and planning strategies needed and role of different departments in implementation of LEZ.

Key highlights

There is no one way of implementing LEZ strategy – scope varies according to the objectives and needs: Though the broad purpose of implementing LEZ is to improve air quality, reduce carbon intensity of transport, promote accessibility and usage of public transport, and accelerate electrification these initiatives vary widely in scope and approaches. These take the form of — emission standards based restriction; Clean air zones; Ultra-low emission zones for only zero emission vehicles; and specific action like diesel car bans. These also take the form of access restrictions that may include time-restrictions, temporary emergency restrictions on movement of vehicles; pedestrian zones etc. These are also introduced in areas of historical importance and high footfall areas.

The LEZs approach are largely designed to reduce air pollution and congestion and also promote fleet electrification – showing benefits: Several LEZ's operate in European and Chinese cities with interest growing in the US cities as well. London saw aggressive reduction in emissions due to implementation of LEZ and ULEZ. German cities showing an increase in the number of electric vehicles and fleet renewals based on cleaner emission standards. Oslo, Norway introduced an LEZ with congestion charging as a strategy.

Target specific LEZ approach: LEZ strategy is also being designed to target the most polluting vehicle segments. In China for instance, Beijing LEZ has targeted heavy duty diesel vehicles to promote fleet renewal and augmentation of China 6 emissions regulations.

Leveraging LEZ to speed up electrification of vehicle fleet: There is a strong interest globally to leverage LEZ or ULEZs to speed up adoption of electric vehicles. The emerging evidence indicates the potential of this change – as in Amsterdam, Paris, China etc. .

Necessary to build public support for LEZ strategy and to fight push backs: **Some of the LEZ projects are facing strong resistance as the benefits of such interventions are often not well understood. Expansion of London ULEZ is facing strong public resistance. Also in New York there is opposition from people living in New Jersey and traveling to New York. Communication and public awareness strategies to build public support for such schemes.**

What about India?

Even though interest in LEZ approach is growing in Indian cities there is no holistic project on ground yet. There are only a sprinkling of instances in which some area based and emissions based restrictions have been imposed with a limited scope.

Some of these practices have provided the foundation for the LEZ strategy. For instance in Delhi, as part of the air pollution control effort, restrictions and entry fees have been imposed on each truck entry daily. Extra air pollution cess has been imposed on each litre of diesel sold in the city. All public transport and local commercial transport are required to operate only on compressed natural gas (CNG) or other clean fuels. Pollution charge has been imposed on all diesel cars with 2000 cc engine and above that are sold in Delhi.

Similarly, targeted streets like Ajmal Khan market and Shahjahanabad have been fully pedestrianised where entry motorised traffic is restricted. Delhi has

also adopted parking rules for area wide parking management and capping with variable pricing to manage demand.

There are several other instances in other cities including Bangalore, Pondicherry, Hyderabad etc where stretches of streets have been pedestrianised – either fully or partially.

Increasingly now, under a diverse set of schemes and programmes including Smart city programme, AMRUT, Clean air action plans, several bus schemes among others, cities are being mandated to redevelop streets and expand infrastructure for walking and cycling and public transport. On the other hand central and state incentive policies have emerged to promote electrification of vehicles. But these initiatives are fragmented, limited in scope and are not amenable to attain scale.

LEZ strategy provides the opportunity to tie these all up to enable their integrated implementation on an area wide scale in a city especially targeting polluted and congested areas and catalyse city-wide changes. This combines the strategies of improving accessibility, reliable public transport services, walkable streets, efficient last mile connectivity while scaling up transition to clean and zero emission vehicles. Such targeted and integrated approaches can also unlock resources for these initiatives that otherwise remain tardy.

Therefore, as the interest in the LEZ strategy is growing in Indian cities, it is necessary to understand what it will take to make this happen and what are the prerequisites for such an intervention. As there is no live project on ground yet, the Centre for Science and Environment has carried out stakeholder engagement to identify the legal and regulatory underpinnings that can help to create the mandate in a city and the preparedness needed at the city level to get all the departments galvanized for this strategy.

A special deep dive engagement was carried out in the capital city of Bhubaneswar which is the only city so far that has moved officially and formally to assess and plan a LEZ as part of its clean air action plan and the concept plan is underway. The Odisha State Pollution Control Board supported by the GIZ is developing a draft plan for a 5 km radius area around Lingaraj Temple in the city.

It's necessary to understand the pre-requisites and the role of different departments if this plan is implemented. What is needed to create the mandate, for the diverse set of state departments – including state pollution control board, state transport department, municipal corporation, bus service providers, and energy

providers — who will have different roles to play in the implementation process. Understanding their role, perception and expectations becomes necessary. Therefore, the engagement with the Odisha State Pollution Control Board, Bhubaneswar Municipal Corporation, Department of Transport, Capital Region Urban Transport (CRUT) and discoms to understand the level of sensitisation needed, and the pre-requisites at this nascent stage.

Key highlights

Need leveraging of inherent mobility advantages of the city to enable LEZ implementation: A city that has paid attention to improving public transport services, accessibility, has inherent advantages in short travel distances, high modal share for walking and public transport, and initiated electrification of vehicle fleet has a stronger opportunity to build LEZs.

Bhubaneswar is one such city that has witnessed aggressive expansion of bus service and electrification of bus service over the last few years. Walk trips are 49 per cent or nearly half of all trips, and bus and paratransit trips are 15 per cent. Two-wheelers are two thirds of all vehicles but carry only one third of the trips in the city and cars carry only 5 per cent of the trips. Close to 59 per cent of the travel trips fall in the range of 2 km distance and nearly all below 5 km range. Within 5 years of operation, Mo-bus witnessed a 3.2 times increase in ridership. Further intensification of these services can be a strong enabler for LEZ implementation.

Clean air action has catalysed interest in LEZ: The SPCB has taken the lead to introduce this strategy as part of their clean air action. This is being seen as a strategy to mitigate growing air pollution in the city, reducing growing emissions intensity from vehicles and combating the rate of motorization. The SPCB has leveraged the state tourism plan and the Heritage policy that provides for area improvement of a few identified areas and monuments that are important for tourism. One of them is the Lingaraj temple in Bhubaneswar that attracts considerable domestic tourists. This has been taken as the basis to expand the core area and broaden the scope of application.

The clean air action planning under the National Clean Air Programme (NCAP) has been leveraged. Also any city can leverage the Environment Protection Act 1986, and the Air (Prevention and Control of pollution) Act 1981 can provide a legal back up. The Air Act 1981 provides for declaring critically polluted areas for more purposeful action. The clean air plans in combination of LiFE mission provide for enhancement of public transport, walking and cycling infrastructure, parking as a demand management policy,

In addition, the Clean Air Action plan and micro action plan for Bhubaneswar under the NCAP programme has provided for augmentation of public transport services, expanding infrastructure for walking and cycling, implementing measures like parking policy as a vehicle restraint measures and electric vehicle policy for zero emissions transition. All of these provisions can be integrated and further enhanced with supportive congestion pricing etc to implement LEZ comprehensively.

The idea is still at a planning stage and not integrated with the larger institutional process of the government. When adopted by the state government this can provide the mandate for interdepartmental coordination and planning for implementation.

Integrated inter-departmental plan needs to roll: At this stage, the actual contour and scope of the LEZ plan with respect to vehicles is not available. Entry and exit regulations for vehicles based on their emission standards and zero tailpipe emissions, level of charges, incentives and exemptions for the local residents, fleet renewal based on electrification, strategies for tourists etc are possible intervention points. But these would be discussed for final adoption and phase in.

This will require a lot of leveraging of the existing policies like the electric vehicle policies including the special incentives for government owned fleet and for government officials, scaling up bus transport and walking and cycling infrastructure, parking policy as a demand management measure etc. Transport department can additionally leverage the strategies for phase out of old vehicles, scrappage of end-of-life vehicles and scrappage incentives. In fact, the Central Motor Vehicles Rules 1988 and the Central Motor Vehicles Rules (CMVR) 1988 have multiple provisions to support implementation of LEZ. For instance, section 115 of the Motor Vehicles Act, 1988 gives power to the state to control traffic, restrict use of vehicles, if satisfied that it is necessary in the interest of public safety or convenience.

Similarly, the Bhubaneswar Municipal Corporation (BMC) is responsible for infrastructure for walking and cycling in the city, street scaping, vending zones, parking policy with area management approach. These strategies can be adapted for LEZ implementation. Likewise the Capital Region Urban Transport (CRUT), the public transit agency is responsible for provision of bus and auto services in the city and nearby region. They need to be on board to intensify bus services and last mile feeders in the proposed LEZ area to enable easy transfers from personal vehicles to buses. At the same time the energy providers the DISCOMs, charging providers, municipal corporations need to assess the local power supply and upgrades and plan intensification of charging infrastructure.

Linking LEZ with fleet electrification can accelerate zero emissions transition: A lot will depend on the way the LEZ will be designed to create opportunities for electric vehicles. Given the fact that two wheelers dominate the local fleet in the zone around the Lingaraj temple in Bhubaneswar with reasonably high usage of three wheelers, a targeted policy of fleet renewal based on electrification can be accelerated. Demand incentive schemes coupled with lower operational costs and lower total cost of ownership can speed up electrification of these vehicle segments in the area if targeted policies are followed. Also targeted provisioning of public charging facilities including battery swapping facilities and facilities for home charging (more suitable for two and three wheelers) can catalyse change. Also once the mandate for LEZ is in place electric bus service can be intensified in the zone. Such a combined strategy can lead to significant reduction in local pollution and energy intensity of vehicles and mass commuting.

Need mandate: In principle there is tacit support for such a strategy and it is considered doable. Departments agree area based approach is possible and they have legal and regulatory leeway to implement strategies required for area focussed LEZ approach. However, there is a consensus that this will require a formal adoption and a mandate to institutionalise the process. There is also adequate legal handle that can be aligned and leveraged.

Need public engagement to demystify the concept and build acceptance: The global experience shows that as these strategies impact the community and the change depends on a range of individual choices and decisions, advance action to build public awareness and outreach strategies become necessary to build acceptance of the programme. This also requires early assessment of the differential and disproportionate impacts that these measures are likely to have on different socio economic groups and the policy needs to integrate adequate mitigation strategies in terms of incentives or differentiated pricing etc for targeted groups.

The way forward

As Bhubaneswar takes the lead and the concept is also gaining ground in other cities like Delhi and Pune, it is necessary to lay out the key steps and build on the insights from the ground. This strategy would need to be designed to reduce emissions from vehicles, speed up transition to clean and zero emission vehicles, promote public transport usage, and improve accessibility of the area for all road users. This is an opportunity to tie all key mobility transition initiatives including accessibility, improved connectivity, public transport strategies, vehicle restraint measures and fleet electrification in an integrated framework for implementation in delineated areas of the city that can also have much wider influence in the larger

catchment of the city. However, such a strategy will require a few prerequisites for effective implementation.

Define the mandate for implementation of LEZ: There is a need for a clear mandate from the state governments for implementation of LEZ. That it needs to be backed by administrative or legal order outlining the roles of the concerned departments by fixing responsibilities. As several approaches are needed for implementation of LEZ, different departments will have to come together to implement in coordinated way the entry regulations for different types of vehicles; entry charges as per the emissions and congestion potential of vehicle segments; electrification of vehicle fleet, enhance public transport and paratransit services and related infrastructure including passenger information system and improved frequency; targeted scrappage policy and incentives for fleet renewal; adequate charging infrastructure; street redevelopment plans for improving accessibility; implementation of parking management area plans as a demand restraint measures among others.

Defining the scope of the LEZ programme: Cities embarking on this programme need to decide the scope and parameters to design the LEZ programme. This is expected to be widely diverse across cities depending on the local requirements. There are widely differing views from considering only vehicular pollution and accelerating electrification of the fleet to other sources of pollution. However, addressing vehicular pollution and transitioning to electric vehicle programs along with improved accessibility and connectivity will be central to this strategy.

Identification of the target areas in cities: The urban development departments, urban local bodies and SPCBs need to identify the areas where the LEZ can be implemented, considering factors such as pollution and congestion levels, population and vehicle ownership patterns, profile of the vehicle fleet, transit traffic volume etc. The size of the cordoned area, its demographics, impact area, and composition of residential and commercial areas, composition of vehicles, pedestrian footfall, connectivity need to be surveyed and measured. Globally, the focus has been on congested and polluted city areas and heritage areas that attract a lot of tourist traffic.

Different parts of the city may qualify to be a Low Emission Zone based on different qualifying criteria. For example, these may include historical centres of tourist importance, commercial areas with high footfall, multi-modal hub etc that can be prioritised.

Need indices and data for profiling vehicle stock in the area for regulating vehicular movement: Local surveys are needed to assess the distribution of vehicles by fuel, age and weight to design the programme. Such profiling can help to identify vehicle categories to be targeted, dominant emissions standards of the fleet, fuel consumption, emissions profile and more.

Assessing local air quality and emission levels of different genres of vehicles to regulate vehicular movement based on emissions standards: As the overall purpose is to reduce local exposures to vehicular pollution it becomes necessary to achieve faster fleet renewal by replacing or restricting movement of older vehicles that meet outdated emissions standards. Often such schemes insist on providing preferential incentives for zero emission vehicles or vehicles meeting the latest emissions standards. The objective is to reduce particulate matter, nitrogen oxide, among others. This can be further enabled by introducing more advanced remote sensing monitoring in the city that can profile the emission levels of a much larger fleet size help to identify the gross polluters and the worst emitters that can also be selectively eliminated.

Improve on-road emissions monitoring and measurement techniques to aid in implementation of LEZ: Globally, there is growing interest in application of remote sensing measurements in generating real world emissions data from on-road vehicles for fleet profiling. That helps to characterise emissions of different genre of vehicles by fuel, age, technology vintage etc and identifies the worst emitters on the road. Such assessments carried out under The Real Urban Emissions Initiatives of the FIA Foundation have brought out the profile of real world driving emissions in several cities including London, Paris, Berlin, Jakarta among others. The remote sensing devices are installed on the roadside for Real Driving Emissions (RDE) tests that can measure emissions instantaneously from vehicles passing by. These can measure gaseous pollutants including NO, NO2 and CO etc. These can be benchmarked to identify the worst emitters. This can help with screening of vehicle emissions to identify high or low polluting vehicles and vehicle types under specific driving conditions. Such evidence also helps to build support for the programme when the high level of on-road emissions are transparent. India needs to make this strategic transition and go beyond the current pollution under control certificate (PUC) programme.

Profile the vehicular ownership pattern and differential impacts of LEZ restrictions on income groups to plan exemptions and incentives in the LEZ: It is necessary to assess the differential impacts of the scheme on local residents. It is important to classify exemptions depending on predefined criteria and to

minimize the impact on the vulnerable communities. Globally, LEZ is controversial as it is also seen as unfair restrictions to penalize drivers of older vehicles who may not be able to afford to upgrade to more environmentally friendly models. This matter has also come up in cities that have attempted to phase out older vehicles. Questions have been raised about its impact on older people and limited income groups who may find it difficult to replace vehicles. Moreover, in Indian cities vehicle ownership is dominated by two-and three wheelers that are different from global cities. Both exemptions and incentives will have to be informed adequately.

Planning for EV deployment is necessary for an LEZ: This is needed to ensure adequate infrastructure enabler for low emission vehicles within the area. Building complete streets act as an enabler to LEZ. Complete streets encourage people to walk, cycle and socialise on streets. This can be a conducive environment to promote LEZ in identified zones in a city. Implementation of LEZ involves a complex set of factors as this has to deal with a diverse set of dynamic situations in the local setting.

Prioritizing pedestrian movement and access to public transport: As the LEZ operates as a vehicle restraint measure with a range of restrictions by type of fuel, age, pollution potential etc, each LEZ will require public transport accessibility assessment and well- designed infrastructure for pedestrian movement, last mile connectivity and improved multi-modal integration. If an LEZ is identified within a tourism network, it is important to identify routes for intermediate transport, routes for e-vehicles etc. to allow movement. These need to leverage all the legal provisioning of transit oriented development, tied metro funding for walking and cycling infrastructure and feeders, street design guidelines, parking policy etc.

Strategy for incoming traffic and other modes of transport in LEZ: This will also require a strategy for the vehicular traffic originating outside the zone as their entry into the zone will be regulated based on their emission levels. This will have implications for the larger catchment area in the city. Specific strategies are needed to regulate movement according to the duration and time of the day depending on the peak and non-peak hours, congestion and emission levels etc. This will also influence a larger catchment and also a range of other transport including aggregators, buses, and paratransit. This will require an interface between the LEZ policy and the city wide policy on setting targets for overall improvement in emission standards, fleet renewal and electrification.

Identifying key stakeholders and engaging with them in the planning process: The success of LEZ will require local public support and participation

of the concerned departments. LEZ development involves multiple stakeholders. Identify and classify roles and responsibilities of all stakeholders. There must be a regular timeline for interaction and engagement with all stakeholders while working towards LEZ implementation. This requires sensitizing the residents about the plan, its differential impacts, efforts to improve overall accessibility and connectivity to the area, public transport infrastructure, vehicle charging infrastructure etc. This requires a detailed mitigation strategy.

Develop local area plans and introduce other demand management measures like parking caps and pricing as a prerequisite: Restrictive action on vehicular movement cannot be enforced overnight in isolation. This needs to be supported by a range of other demand management measures and urban planning measures in the area. As the restrictive action on vehicles requires scaling up of local mobility options, it is necessary that detailed plans are made based on mapping of local activities, road users, multi-modal integration of points and facilities, allied traffic, pedestrian and local circulation plans, parking caps and parking pricing strategy etc. These are prerequisites for establishing LEZs. A range of demand management measures including parking need to kick in.

Establish enforcement and compliance mechanisms: Establish enforcement mechanisms to ensure compliance with the LEZ regulations, such as fines or penalties for non-compliance. This will also require an intelligent transport system and camera based smart monitoring. Fines and penalties are commonly used to enforce compliance with the LEZ regulations. This can include daily fees for non-compliant vehicles, fines for repeat offenders, and suspension of vehicle registration. Automatic number plate recognition (ANPR) cameras need to be used to read the number plates of vehicles entering the LEZ. The cameras can identify whether the vehicles meet the required emission standards or not, and fines can be issued automatically to non-compliant vehicles.

Monitor and evaluate implementation: Establish a system to monitor and evaluate the effectiveness of the LEZ, including monitoring air quality levels, tracking the number and type of vehicles entering the LEZ, and evaluating public perception and compliance with the regulations. This will also require adoption of more advanced monitoring of real world driving emissions based on remote sensing measurements to inform the LEZ process. This will also require assessment of local air quality with real-time air quality monitoring systems, signage to indicate the boundaries of the LEZ etc. On-road inspections involve spot checks of vehicles entering the LEZ to ensure compliance with the emission standards

Invest revenue from permit/entry fees for local area development. This is needed to build public support for the LEZ strategy. People will volunteer to support such schemes if they see direct benefits flowing back in their zone. This requires a local area improvement plan and investment in local infrastructure for walking and cycling, and other facilities for local area improvement.

Timeline of implementation: LEZ concept is likely to include several strategies for phase in with milestones. These need to be implemented according to a timeline. There need to be a clear set of guidelines with a timeline for transition and to encourage more and more people to comply.

Exemptions and permits to mitigate the impacts of the LEZ restrictions: Given the differentiated and disproportionate impact of LEZ provisions on the local community, a combination of permits, exemptions and incentives may have to be worked out to minimise the impacts. Some LEZs may provide exemptions or permits for certain types of vehicles or for vehicles used for specific purposes, such as emergency vehicles or public transit among others.

Education and outreach: It is quite likely that there might by a lot of disinformation and myths around these new generation measures that might lead to local or even city-wide resistance. This is evident from global experience. Education and outreach is needed to inform drivers/residents about the LEZ, its requirements and its benefits. This can include public information campaigns, signage, and outreach to businesses and residents in the LEZ. It is necessary to plan public outreach and education efforts to promote awareness of the LEZ and its benefits, as well as to educate residents and drivers about the regulations and compliance requirements. It is important to establish a clear enforcement strategy for the LEZ and to communicate this to the public. This can help to ensure that the LEZ is effective in improving air quality and reducing emissions.

Low emission zones: diverse global approaches

As Indian cities embark on the possible introduction of low emission zones in targeted areas of cities as an air pollution and transport decarbonization measure, it is necessary to understand what it entails and the scope of its applications.

The global experience shows that the low emission zone (LEZ) strategy does not have one specific definition. It encompasses diverse approaches that vary in scope and design. Some of its early initiatives include the environmental zone introduced in Sweden around mid to late nineties. It grew in scope when Umweltzone (Environmental Zone) was introduced by the German government in 2008 to restrict access of high-polluting vehicles in designated areas.

Since then, other countries and cities across Europe have implemented their respective LEZs, including London, Paris, and Stockholm. In the UK, the first Low Emission Zone (LEZ) was introduced in London in 2008, followed by the other cities such as Birmingham and Leeds.

More layers of approaches have been added since then. These include ultra-low emission zones (ULEZ) and zero emissions zones (ZEZ). Globally these measures have been implemented largely to reduce emissions from vehicles from targeted zones by restricting polluting vehicles powered by internal combustion engines and by promoting use of clean technology and fuel and zero emission electric vehicles.

The range of restrictions imposed on vehicles within LEZ vary across locations. In some zones certain types of vehicles, such as buses or lorries, are restricted while in others cars and motorcycles may also be restricted. The clean emissions standards that vehicles must meet to enter the zones also differ depending on the location and the approach.

A recent study by Mckinsey suggests that LEZs are surging globally, 150 cities have implemented LEZs. In European Union (EU), 16 original equipment manufacturers (OEMs) with 65 per cent vehicle market share have also announced exit dates for internal combustion engine (ICE) vehicles to comply with the EU 2030 carbon dioxide reduction (CO2) targets.1 This can further accelerate expansion of LEZs in cities.

Broadly, there are a few key approaches to restrictions in LEZ areas.

Emission standards based restrictions – This type of LEZ depends on emission based regulations enacted on movement of vehicles. It requires vehicles to meet specific emission standards as recommended to be able to enter the city or defined zone. Vehicles are typically required to have a specific level of emissions, such as BS VI standards. Cities that recommend emission based restrictions for an LEZ, they are likely to take the following approaches:

Clean air zones (CAZs) – The CAZs are typically found in larger cities and require vehicles to meet certain emission standards. Vehicles that do not meet these standards may be charged a fee to enter the zone.

Ultra-low emission zones (**ULEZ**): The ULEZ are very similar to CAZ, just that only zero emission vehicles or ZEVs are allowed to enter these zones. The ULEZs are typically designated to small identified pockets in a city characterized by high footfall or congestion.

Environmental zones: The environment zones include small areas in a city, typically around the historic importance of tourism areas. Tourism zones in Indian cities can be identified and designated as environment zones

Diesel Bans: As the name suggests, unlike a blanket restriction based on emission standards, some cities ban specific polluting fuels. This includes restrictions on diesel cars.

Access restrictions based LEZ: In densely populated urban areas where air pollution is a major problem, cities restrict access to certain high-emission vehicles, such as diesel trucks and buses, and these are restricted from entering the zone unless they meet certain emission standards or zero emission requirements. Vehicles that do not meet the required emissions standards are either prohibited from entering the zone or are subject to a charge.

Restrictions on movement are driven by emission goals or congestion reduction goals. These may include allowing only electric vehicles and non-motorized vehicles in a given area. Similarly motorized vehicles with only a certain amount of pollution may be allowed to enter. Banning diesel vehicles while allowing petrol vehicles to enter is also a kind of partial restriction. This also adopts congestion charging as a strategy to operationalize the principle of polluters pay to restrict vehicles from entering a certain area

Time-restrictions based low emission zones: These are LEZ that restrict access of high emitting vehicles during specific times of the day. Cities that regulate entry of freight vehicles from 9am to 9pm can be grouped under this category of LEZ. Cities that restrict polluting vehicles in the city core during peak hours to facilitate movement of pedestrian and non-motorised transport (NMT) can also be grouped under this category.

Temporary/emergency low emission zones: These are LEZs that are established for a limited time period, such as during a major event or a period of high air pollution. Emergency LEZs have fixed protocol and the city is mandated to comply as and when required

Odd and even days are also temporary LEZ strategies that do not have fixed schedules, but the city administrator can decide to introduce LEZ's to address peak pollution periods in a city.

Low emission bus zones - Some cities have designated certain areas as low emission bus zones, which seek only buses or public transport to operate in the area. This strategy can help to push the shift from personal to public transport buses.

Pedestrian zones based on low emission zones: Some cities have designated certain areas as pedestrian zones, where only pedestrians and bicycles are allowed. This type of low emission zone can help reduce emissions by limiting the number of vehicles in the area.

The global experience suggests that there is no single prescription of doing it and is predominantly driven by the local imperatives and the policy drivers. Creating a LEZ requires a vision and a city level objective, based on which restrictions and regulations can be worked upon. The LEZ strategy offers cities an opportunity to take an integrated approach to implementing public transport, accessibility, vehicle restraint measures and fleet electrification.

Learning from the global experiences

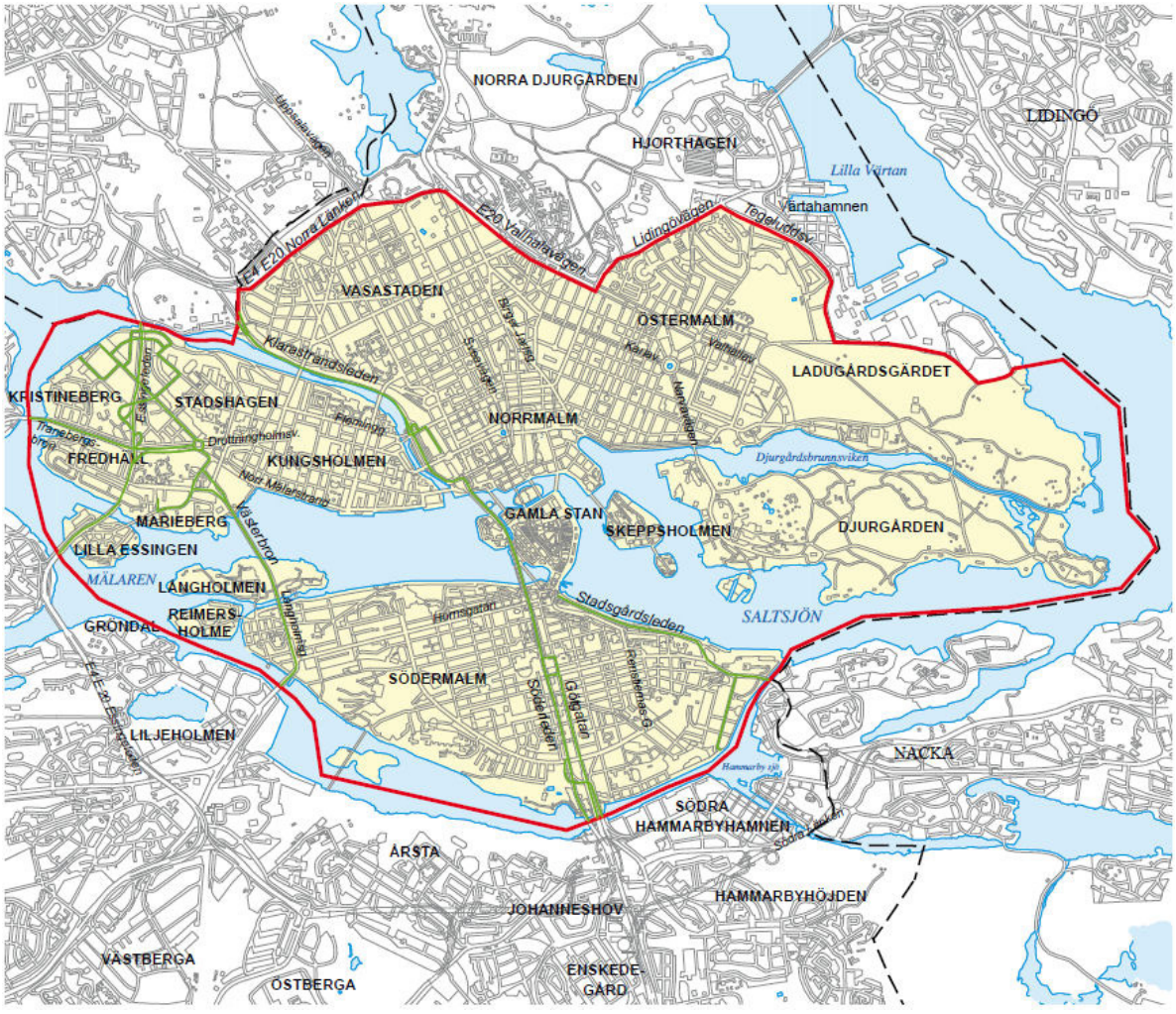
Low emission zones to address air pollution – The LEZ's were first introduced in the nineties in Sweden2 to reduce emissions from vehicles. They used LEZ to introduce area based access restrictions for high emitting vehicles in certain parts. This targeted mostly the polluting personal cars. Since then many cities have used LEZs to mitigate air pollution. There are a wide range of case studies to suggest how LEZs have been leveraged to combat air pollution. (Table 1 Overview of cities that implemented LEZ).

According to a study by the Swedish Transport Administration, the LEZ led to a reduction in the concentration of nitrogen oxides (NOx) in the city's air by 10-15 per cent in the first year of its implementation. The Stockholm LEZ has also led to improvements in public health, as it is estimated to have prevented approximately 90 premature deaths and 350 hospital admissions each year due to air pollution-related illnesses. The zone has been expanded over the years to include stricter emissions standards and a wider range of vehicles.

Stockholm LEZ considers the Euro standards of diesel vehicles and the Swedish traffic ordinance standards for petrol vehicles. Implemented in 2007, this requires all vehicles to meet certain emissions standards to get an entry into the city center. The Stockholm LEZ targets all types of vehicles, including passenger cars, trucks, and buses. It uses camera-based enforcement systems to detect vehicles entering the zone and check their emissions standards against a national vehicle registry. Vehicles that do not meet the required emissions standards are subject to a daily fee for entry. The fee is based on the vehicle's emissions level and ranges from SEK 35 to SEK 135 (approximately Eur 3.50 to Euro E13.50). I(Figure1: Low emissions zone in Sweden).

London saw aggressive reduction in emissions: Based on 2 million emission records, London's ULEZ has led to 44 per cent reduction in nitrogen dioxide (NOx) ,and 61 per cent to 98 per cent reduction in particulate emissions3. London Ultra Low Emission Zone (ULEZ)4, was implemented in April 2019. The ULEZ covers an area of central London, including the same area as the previous T-charge zone. The ULEZs concept in London aims to ban petrol and diesel from entering the central area. According to a report by Transport for London, NOx emissions from road transport within the LEZ fell by 36 per cent between 2008 and 2010. The

Figure 1: Low emission zone in Sweden

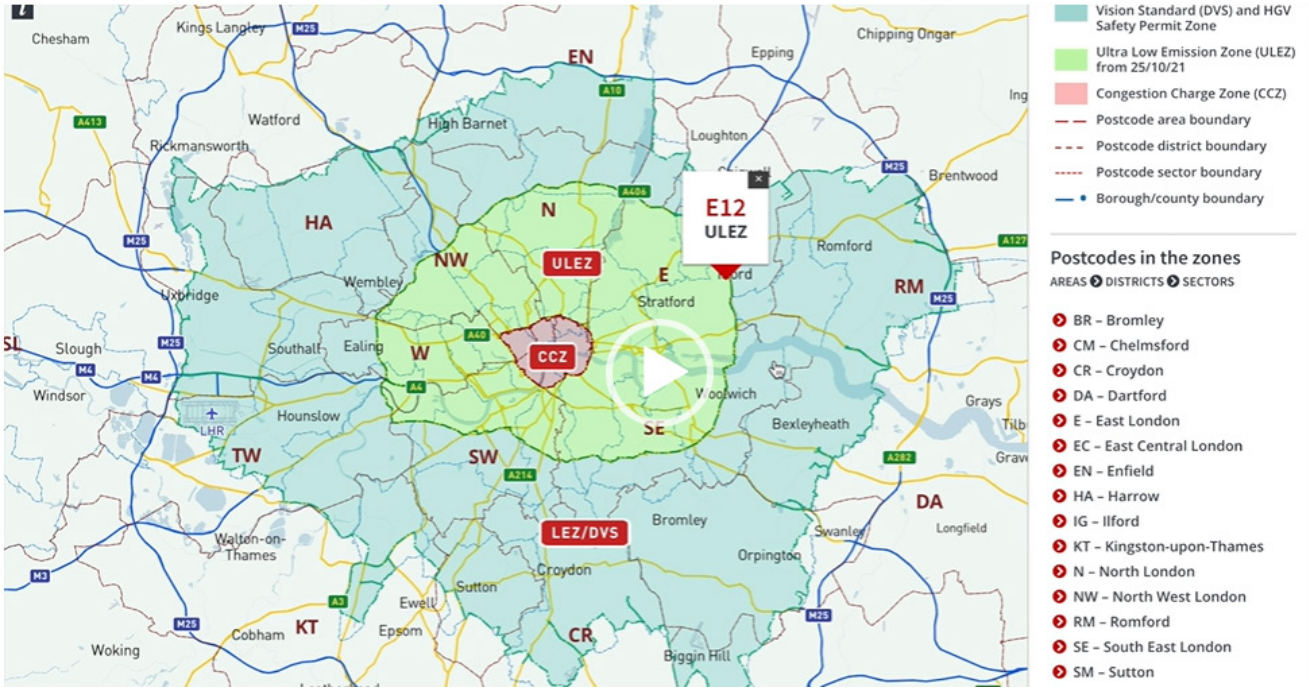


Source: https://urbanaccessregulations.eu/countries-mainmenu-147/sweden-mainmenu-248/stockholm

report also estimated that the zone has prevented more than 20,000 premature deaths between 2010 and 2020. (see Figure 2: London low emission zone and ultra-low emissions zone).

Implementation and compliance in Germany – Referred to as "Green Zones", Germany introduced LEZ in 2008 in 9 of its major cities including Berlin, Frankfurt, Hanover, Cologne, Manheim, Munich, Ruetlingen, Stuttgart, and Tubingen. Based on classification of Euro standards three kinds of stickers were introduced. Red stickers indicate complete ban and deemed unfit for use. Yellow stickers are for Euro 2 and Euro 3 diesel vehicles with particulate filter. And

Figure 2: London low emissions zone and ultra-low emissions zone



Source: https://hxra.org/2022/08/09/ulez-havering-council-response-sent-to-the-mayor-of-london/

Table 1 Overview of cities that implemented LEZ

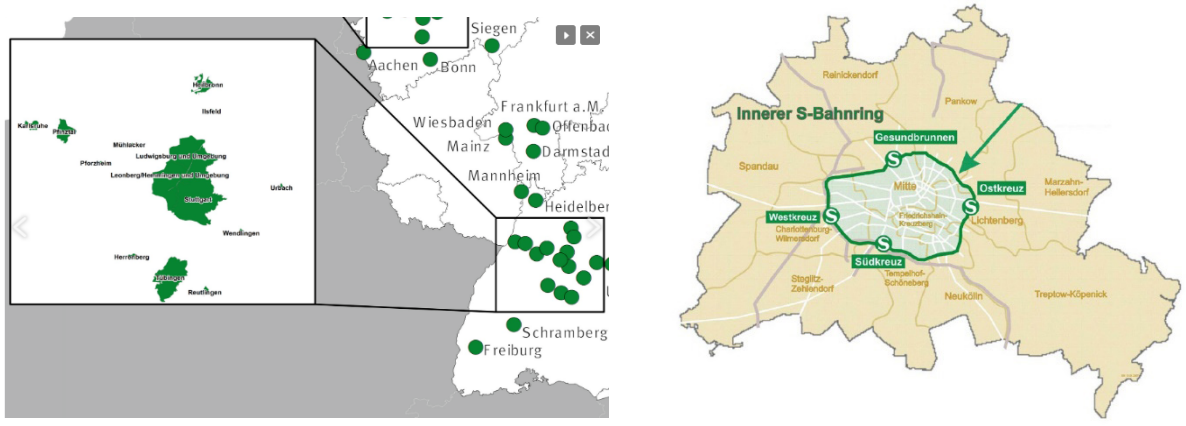
Location	Name of LEZ Policy	Objective	Timeline	Remarks	Expected Outcome
Amsterdam, NL	Environmental zone as part of "Action Plan for Clean Air"	Extension of existing LEZ to passenger cars, phase-out of ICE cars by 2030	Gradual introduction as of 2020 with ban of Euro 3 diesels or older within the a10 ring-road area, zero-emission mobility for all modes and the whole city by 2030		Goal of respecting WHO guidelines by 2030, which is expected to raise life expectancy of inhabitants by 3 months.
Brussels, BE	Low-Emission Zones	Development of the existing LEZ with a phase-out date for diesel, petrol and LPG vehicles	Phase-out of diesel vehicles from the LEZ by 2030, and of petrol and LPG vehicles by 2035	The existing "Bruxell'Air" scheme will be revised. It currently provides financial support to residents for scrapping their car.	The Brussels Region plans to align with and respect the WHO air quality guidelines (that for particulate matter are stricter than current European Union limits).

Location	Name of LEZ Policy	Objective	Timeline	Remarks	Expected Outcome
London (only Islington and Hackney), UK	Ultra-Low Emissions Streets (ULEV streets)	Petrol and diesel vehicles are banned from Monday to Friday from 07:00 - 10:00 and 16:00 - 19:00. Access is restricted to walking, cycling and low emissions vehicles only (vehicles that emit less than 75g/km of CO2).	Zero emissions zones (ZEZ) in place since July 2018	A public consultation showed that 56 per cent of citizens supported the ULEV streets proposals, with 40 per cent opposing and 4 per cent neither supporting nor opposing.	Expected reduction in traffic by 90 per cent in the streets concerned, with focus on delivery Vehicles.
London, UK	Zero-Emission Zone	Phased introduction of a ZEZ covering central London and investigation of a City-wide ZEZ	local ZEZs covering the Barbican and Golden Lane estates and the city cluster by 2022		Goal of 90 per cent of motor vehicles entering the Square Mile are zero emission capable by 2030
Madrid, ES	Madrid Central'	Combination of elements of a LEZ and a ZEZ. Access and parking rights depend on emission class of vehicles. Cars without a sticker cannot access the zone.	LEZ started on 30 November 2018. Diesel vehicles to be phased out by 2024 and petrol vehicles by 2030	The city gives an 'access guarantee' that the Centre can be accessed through public transport and special parking lots are made available.	Observed effects include NO2 concentration inside the zone at lowest level since start of monitoring in 2010. No increase in pollution in the periphery
Oxford, UK	Zero-Emission Zone	Under current proposals vehicles that emit less than 75g of CO2/km from the tailpipe and capable of at least 10 miles of zero emission driving would be allowed into the zone.	Low emission and zero emission requirements planned to be introduced from 2020 onwards with two zones with different requirements.		Goal of setting a journey to zero transport emissions in Oxford by 2035
Paris (City), FR	Low-Emission Zone	Phased introduction of a LEZ with phase-out of diesel vehicles by 2024 and petrol vehicles by 2030 as part of Paris Climate, Air and Energy Plan	First phase in force since 15 January 2017. Since 1 July 2019 ban of vehicles up to category 'Crit'Air 4' (diesel cars from before 2006, petrol cars from before 1997).	Does not apply to light-duty vehicles during the night and week-ends.	Expected reduction of emissions: NOx by 19per cent, PM10 by 8% and PM2.5 by 13 per cet. Goal: half exceedances of WHO guidelines.

Location	Name of LEZ Policy	Objective	Timeline	Remarks	Expected Outcome
Paris metropolitan area, FR	Low-Emission Zone	Phased tightening of LEZ with ban of vehicles up to Crit'air 2 category (all diesel cars) by 2024 and phase-out of all vehicles with an internal combustion engine by 2030	Since July 2019 first step of LEZ with ban of oldest vehicles (diesel from before 2001, petrol from before 1997).	Opinion polls show 75 per cent of inhabitants support the introduction of a LEZ64, financial support of up to 17,000 EUR for purchase of a clean vehicle.	Goal of "100 per cent clean vehicles by 2030"

Source: Briefing by Transport and Environment EU, Sept 2019

Figure 3 Green Zones in Germany



Source: https://www.environmentalbadge.com/validity-of-environmental-badges/

green is the most accepted sticker indicating vehicles that can either be an electric vehicle, petrol, LPG, Hybrid and diesel standard of EURO 4 or EURO 3 with a particulate filter. (see *Figure 3 Green Zones in Germany).*

Low Emission zones in France adopted time based restrictions on polluting vehicles – In Paris and Marseille, the LEZ is applicable on weekdays. It bans entry of heavy duty trucks and buses. Each vehicle is issued a sticker to identify the applicable Euro norms. There are also pollution emergency days and area based zero emission neighborhoods in the cities. Vehicles have to apply online and purchase 'Crit Air badge during the air pollution emergency periods. Vehicles failing to comply are levied heavy fines.

- The LEZ is divided into two zones: Zone 1 and Zone 2. Zone 1 covers the area within the A86 ring road and is open to all vehicles. Zone 2 covers the area outside the A86 ring road and is only accessible to vehicles that meet certain emission standards.

- The emission standards for vehicles in Zone 2 are based on the Crit'Air vignette system, which assigns different colored stickers to vehicles based on their emission levels. Only vehicles with a Crit'Air sticker of 0, 1, 2, or 3 are allowed in Zone 2.

- The Heritage Low Emission Zones initiative is part of Paris' broader efforts to improve air quality and reduce air pollution in the city. The city has also implemented other measures, such as bike sharing programs, electric vehicle charging stations, and pedestrian-only zones, to encourage sustainable transportation and reduce car traffic

- The Paris LEZ covers the entire city and is in effect 24/7. It restricts access to certain vehicles based on their Crit'Air sticker rating during times of high pollution, which are announced by the local authorities. The LEZ applies to all vehicles, including cars, trucks, buses, and motorcycles, and fines may be issued for non-compliance.

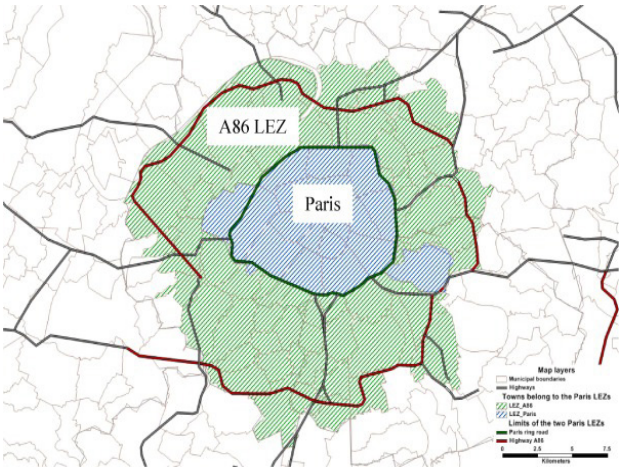
- Crit'Air system is just one aspect of Paris's broader efforts to improve air quality and reduce emissions. The city has also implemented other measures, such as expanding bike lanes and pedestrian zones, promoting electric and hybrid vehicles, and encouraging the use of public transportation.

Milan city is divided into two areas, the overall city "Area B" (LEZ) and the historical central part "Area C" (LEZ + CC) , different regulations exist for both areas. In the Area B any polluting vehicle can't enter, except the registered vehicles. in Area C, electric vehicles, hybrids, mopeds and motorcycles can access for free. M1 vehicles emitting less than 100g/km are free until 1 October 2022. Other vehicles must buy a day pass to enter Area C active from Monday to Friday 7:30 to 19:30. the day pass for area C is Euro 15. (Figure 4: Low emission zones in Paris and Milan).

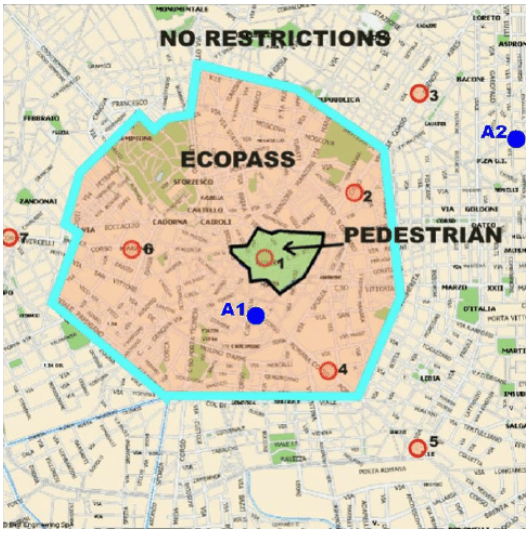
Low emission zones to mitigate pollution in historical areas like Rome: It introduced 'Limited Traffic Zone' or known as "Zona a Traffico Limitato" (ZTL), is one such initiative. The heritage LEZ covers the historic center of Rome, which is a UNESCO World Heritage site, and is marked by signs that indicate the entry and exit points of the zone. The heritage LEZ restricts access to certain vehicles that do

Figure 4: Low emission zones in Paris and Milan

Paris low emissions zone and Crit Air Zone



Milan LEZs



Source: https://www.sciencedirect.com/science/article/abs/pii/S1361920921002753

not meet the emissions standards set by the city. Only vehicles with a green sticker (Euro 4, Euro 5, or Euro 6) or an electric/hybrid vehicle can enter the heritage LEZ. The restriction applies to both Italian and foreign vehicles. The heritage LEZ operates from Monday to Friday, from 6:30 am to 6:00 pm. It does not apply on weekends, public holidays, and during the summer months of July and August. Drivers who enter the heritage LEZ without the appropriate permit may face fines, which can range from Euro 68 to Euro 450.

China's LEZ controls heavy duty diesel vehicles: The Low Emission Zone in Beijing,China, was implemented in 2019 to improve air quality in the city. The zone covers the urban area of Beijing and requires heavy-duty diesel vehicles – trucks and buses — to meet specific emissions standards or be prohibited from entering the zone. The emissions standards required for entry of vehicles into the LEZ is linked to China VI emissions standard.

The Beijing LEZ also provides incentives for vehicles that meet higher emissions standards, such as China VI B or China VI A. They can enter the zone without restrictions or fees. It is a relatively new regulation, and the effectiveness in reducing air pollution levels is still being evaluated. However, according to an early report by the Beijing Municipal Environmental Protection Bureau, the concentration of particulate matter less than 2.5 micron size (PM2.5) in the city's air decreased by 13 per cent in the first half of 2019 compared to the same period in the previous year.

Oslo, Norway introduced a low emission zone with congestion charging as a strategy – In 2016, Oslo levied road toll on vehicles based on Euro standard and fuel type. Restrictions in the city are applicable from 06:00 - 18:00 on weekdays. There is an inner and outer ring and two tariff groups based on different vehicle classes. Electric vehicles are not exempt. Only motorbikes are. Oslo is undertaking a process to convert the central area (city center, Greenland and Tøyen) into a ZEZ, by making it a car-free area. The city uses the AutoPASS system to enforce.

Singapore restricts vehicle entry based on date of purchase: Singapore levies a ban on vehicles entering on the basis of the dates they were bought, and linked to Euro standards and the Euro noise pollution levels as well. The city also offers financial incentives to motorbike owners to get old two wheelers off the roads

Leveraging low emission zones for rapid electrification of vehicle fleets: There is a strong interest globally to leverage LEZ or ULEZs to speed up adoption of electric vehicles. The evidence of actual change is still limited. But the emerging evidence indicates the potential of this change. The EU Clean vehicle directive, 2019 suggests that to improve the proportion of ZEV vehicles in the region, faster electrification by private commercial entities and municipalities in the region must be apt. Provision of adequate public transport and parking rules should be complementary to such initiatives. The European federation for Transport and Environment suggests5 that LEZs are the primary tool to address air pollution and clarity in predictable policies can promote clean vehicles. For example, the Belgian City Ghent provides incentive to upscale use of electric vehicles in addition to implementing LEZ.

Amsterdam currently has five6 LEZs which it plans to expand in size and tighten regulations to meet 2030 targets of 100 per cent electrification of the new fleet. The city has 3000 public charging points in parking spaces and 1000 points on streets to facilitate the ecosystem for EV transition. It has also introduced incentives for and subsidies for electric vehicles to encourage usage. It is estimated that the number of electric cars will quadruple7 in three years from 17,000 now.

Paris LEZs have led to improvement in the share of cleaner vehicles. Evaluation of Paris LEZ from 2016 to now suggests that with each successive LEZ phase, there has been improvement8 in emission standards of vehicles. The upcoming Phase 5 from 2024 onwards will restrict use of these Euro 4 and Euro 6 vehicles to achieve Critical Air limit and that will speed up the adoption. Another study9 by the International Council on Clean Transportation (ICCT) suggests that mass electrification triggered by LEZ policies have led to an increase in utilization of public charging stations to charge EVs.

LEZ in China has led to higher adoption of electric freight vehicles. A study by ITDP suggests that the LEZ implemented in Shenzhen China in 2018 has led to adoption of 70,000 battery EVs for freight operations and installation of 20,000 charging points.

Necessary to build public support for LEZ strategy and to fight push backs

Some of the LEZ projects are facing resistance as the benefits of such interventions are often not well understood and the added costs is seen as onerous. It is necessary to design proper communication and public awareness strategies to build public support for such schemes.

Expansion of London ultra-low emissions zone under pressure: Ultra-Low Emission Zone in London with a daily charge of UK£12.50 for vehicles that do not meet certain emission standards is facing resistance. In November 2022, the expansion was planned to include all London boroughs. To support the ULEZ expansion, a UK£110 million scrappage scheme was introduced for eligible individuals, businesses, and charities, offering incentives of up to UK£2,000 for scrapping older non-compliant vehicles. This is facing resistance.

It has been contested on the grounds of financial impacts, short notice periods, and limited benefits from the scrappage scheme. The matter has gone to court. The Judicial review will examine issues related to the scrappage scheme, consultation process, compliance rates in outer London, and failure to comply with statutory requirements and cost-benefit analysis. There are also concerns around inflation and shortage of second-hand cars. It is estimated that over one million people outside London with non-compliant cars will be affected, and there is no financial support for them. The scrappage scheme is limited to the people of London.

New York: The proposed LEZ scheme would require drivers to pay a toll (congestion charge) while driving through central Manhattan. New Jersey has filed a lawsuit to halt the implementation of this first congestion charge in the US. The congestion charge was approved by the Federal Highway Administration and this aims to generate USD15 billion in revenue for New York's public transport body. The exact toll amounts could be as high as USD23 per day for certain drivers. This has been contested on the ground that this unfairly targets the 400,000 residents of New Jersey who commute to Manhattan daily.

The potential application of LEZ approach in India

The LEZ approach to regulate movement of polluting vehicles in targeted areas is not alien to Indian cities. In several policy designs related to vehicular emission control, area-wise requirements have been adopted to prioritize certain action in cities and zones. Some of these strategies are as follows:

Clean air action in pollution hotspots: This has been driven largely by the air pollution action planning in cities under the National Clean Air Programme where hyper local action plans have been developed at neighborhood scale to address a diverse set of local pollution sources. This approach is not limited to only strategies related to vehicles and vehicular movement, as is done globally, but also includes a range of other pollution sources.

Advanced action in Delhi- NCR: There is evidence that some cities have taken more advanced action within the city limits. Following the Supreme Court interventions, the Delhi-National Capital Region was treated as a high pollution zone and a critically polluted area that led to a range of more advanced action than the other cities. These include the mandate for public transport and local commercial vehicles to run on CNG and other clean fuels, imposition of Environment Compensation Charge (ECC) on all heavy-duty (trucks) entering Delhi, ban on 10 year old trucks, time-based restriction on daily truck entry, 1 per cent cess on diesel SUVs/cars with 2000cc engines and above, Air Ambience Cess imposed on each litre of diesel sold in the city, etc. These measures are meant for only Delhi that is treated as a highly polluting area.

Vehicle entry restrictions in cities: Several cities restrict and regulate entry of heavy-duty vehicles within urban limits from 9am to 9pm or 7am to 9pm. Also motorized vehicles are not allowed during the day in Matheran near Mumbai. Mumbai has designated certain areas as “no-entry” zones for trucks during peak hours and there are restrictions on truck movement along certain roads during the day. Kolkata has imposed a ban on heavy commercial vehicles from 7 am to 11 am and from 5 pm to 10 pm. Chennai has restricted the entry of heavy vehicles from 6 am to 10 am and from 4 pm to 10 pm in an effort to reduce traffic congestion. This is a common strategy.

Zero emission pedestrian streets

Several streets have begun to pedestrianise streets that have improved walkability, accessibility and reduced local pollution and exposures.

- Pedestrianisation of Delhi's Ajmal Khan Road and Shahjahanabad. Pedestrianisation of 21 more commercial streets are planned.

- The MG Road area in Bengaluru has implemented a pedestrianisation project aimed at creating a more walkable and vibrant urban space.

- The Carter Road area in Mumbai has implemented a pedestrianisation project aimed at creating a more accessible and safe environment for pedestrians.

- The Hazratganj area in Lucknow has been pedestrianized to reduce traffic congestion and improve pedestrian experience.

Other area based approaches for demand management including Parking Management Area Plans: This has been mandated by the Supreme Court in Delhi and NCR in 2019. This requires delineation of contiguous area for management of all street activities along with parking to provide for all users while capping the parking supply and applying parking pricing to manage demand and restrain vehicle usage. Delhi Master Plan has additionally provided for curtailing parking supply to restrain personal vehicle usage in areas that are better served by public transport. Punjab in 2017 has also notified Punjab Parking rules for all municipal towns as a demand management measure requiring PMAP.

National transit oriented development policy as well as state level Transit oriented development (TOD) policy in Delhi provide for vehicle restraint measures near transit nodes: This is expected to create the opportunity within 400 sqm area radius around transit nodes to improve accessibility along transit network, impose parking restraint, have density prescription, improve road design and station area design to reduce personal vehicle usage. This is expected to ensure a dense street network with safe movement of pedestrians and NMT and efficient last mile connectivity within the zone. This can be leveraged for creating a more explicit LEZ.

Stepped approach to introducing tighter emissions norms in selected big cities. Since the year 2000 bigger and more polluted cities have introduced tighter emissions standards five years in advance than the rest of the country until 2020 when the standards equalized at the BSVI level across the country.

Only 'EV Area' – Currently, there is no such zone in India. But in 2021 the Prime Minister had announced that Kevadia in Gujarat will be the first EV only city.

What will it take to implement LEZ in Indian cities

As the interest in the LEZ strategy is beginning to grow in Indian cities it is necessary to understand what will it take to make this happen and what are the prerequisites for such an intervention. Towards this end the Centre for Science and Environment has carried out stakeholder engagement to identify the legal and regulatory underpinnings of the initiatives, and also the preparedness needed at the city level to get all the departments galvanized for this strategy.

For this purpose, the capital city of Bhubaneswar was selected to engage with the key stakeholders. The reason for this selection is that this is the only city so far that has officially moved to assess and plan LEZ as part of its clean air action plan and the process is underway. Under the aegis of the Odisha State Pollution Control Board, a draft plan has been prepared with support from GIZ. The 5 km area around Lingaraj Temple in the city has been identified for LEZ implementation. This is a place of historical and religious importance and attracts a floating population of tourists.

In view of the potential implementation of this project and similar opportunities for such initiatives in the city, CSE engaged with the concerned departments in the city to understand some of the enablers and the perception of the key departments. Issues explored include the catalyst for adopting LEZ approach in the city, how the mandate for the initiative can be enabled along with a legal back up, the existing regulations and schemes that can be leveraged to create the mandate for LEZ implementation in the city, and the role, perception and expectations of different departments in expediting the implementation. Understanding these become critical to shape the pathways for implementation.

For this diagnostic assessment CSE reached out to the key agencies including Odisha State Pollution Control Board that has taken the lead to plan a LEZ around the Lingaraj temple in Bhubaneswar, Bhubaneswar Municipal Corporation that is likely to be the key implementing agency from urban planning perspective, Department of Transport that deals with vehicles and vehicle electrification, and Capital Region Urban Transport (CRUT) that provides bus services in the city. Even though the idea is still very nascent and on the drawing board, sensitisation and understanding of pre-requisites at the early stages become necessary. The engagement has focused on the opportunity, barriers and levers.

Inherent advantage of the city to enable LEZ implementation

Any LEZ approach needs to ensure good accessibility and connectivity in the city and especially in the targeted zones. This is needed to enable effective shift to sustainable modes of transport when the LEZ restrictions kick in. The capital city of Bhubaneswar in Odisha despite being in the grip of growing motorisation has also been proactive in scaling up the public transport options. This city registers 1.5 lakhs vehicles annually (16 per cent of the vehicles registered in the state of Odisha). Petrol vehicles dominate at 79 per cent, followed by diesel vehicles at 11 per cent and compressed natural gas (CNG) at one per cent.

Predictably, personal vehicles dominate the fleet (74 per cent two-wheelers and 22 per cent four-wheelers). Noticeably, the share of electric vehicles is equal to that of diesel vehicles (if all categories are combined including e-rickshaws) and as of 2023, the city has witnessed 9 per cent EV penetration. (see *Graph 1: Trend in fuel wise vehicle registration in Bhubaneswar (2018-2023) Graph 2* Vehicle registration by fuel type and composition of vehicle categories as of 2023*)*.

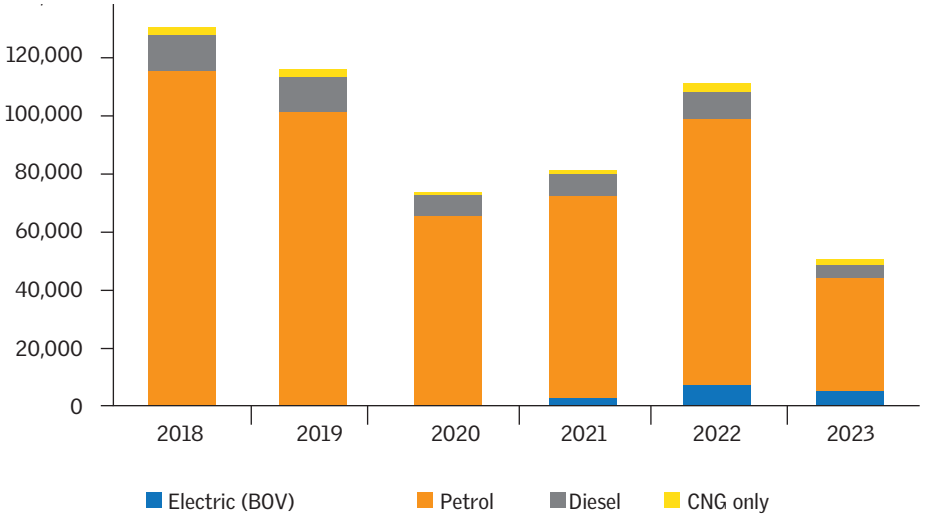
Despite the growing motorization, a significant part of the travel trips are by sustainable modes. While 49 per cent of the travel trips are walk trips, 15 per cent are by buses and para transport and three wheelers. Interestingly, the two-wheeler that constitutes two thirds of vehicles registered in the city is responsible for carrying only one third of the trips generated in the city. Similarly, cars that are 22 per cent of the registered stock, carry 5 per cent trips. (see Graph 3: Modal share in Bhubaneshwar).

It is noteworthy that the share of bus ridership is expected to have increased even further in the city after the scaling up of dedicated Mo bus system 2018 onwards.

Moreover, given the city size and compactness, the average travel distances are small. Close to 59 per cent of the travel trips fall in the range of 2 km distance and nearly all below 5 km range. This is an opportunity to retain, protect and promote public transport, walking and cycling modes in the city. *(see Graph 4: Trip length in Bhubaneshwar)*

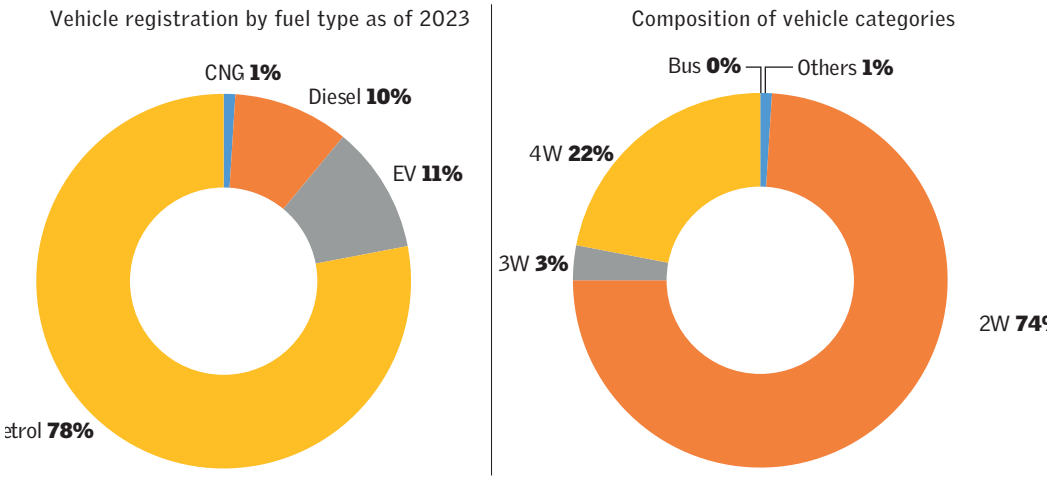
Opportunity in augmentation of public transport bus service: Bhubaneswar is among the newer cities to have introduced a dedicated bus service called Mo bus. Within 5 years of operation, Mo-bus service has witnessed a 3.2 times increase in ridership which corresponds to 1.9 times increase in fleet size and number of routes. The CRUT has now planned to expand bus services for more direct passenger

Graph 1: Trend in fuel wise vehicle registration in Bhubaneswar (2018-2023)



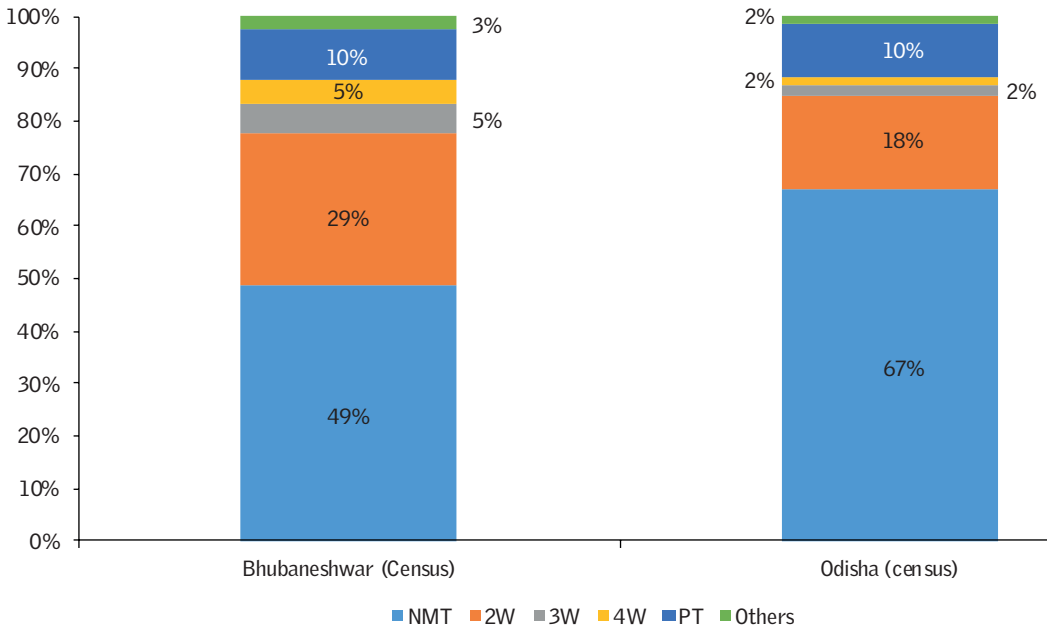
Source: Vahan database

Graph 2: Vehicle registration by fuel type and composition of vehicle categories as of 2023



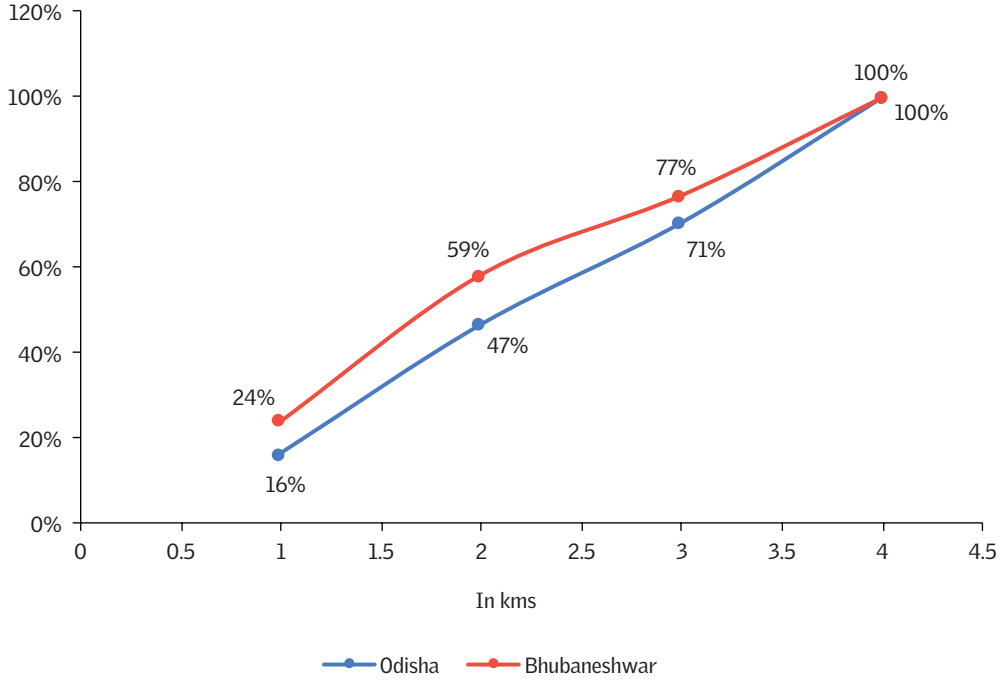
Source: Vahan database

Graph 3: Modal share in Bhubaneshwar



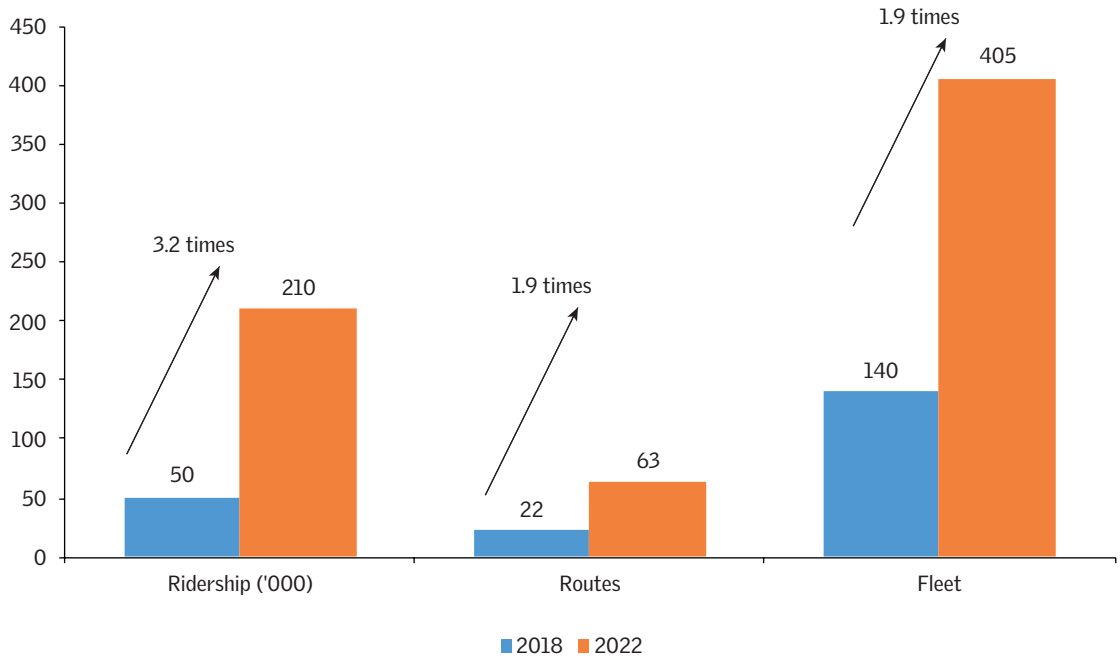
Source: Census 2011

Graph 4: Trip length in Bhubaneshwar



Source: Census 2011

Graph 5: Trend in bus numbers, ridership and bus routes in Bhubaneswar



Source: CRUT

connectivity between Bhubaneshwar and surrounding districts to expand the catchment. Not only the bus numbers and ridership has increased but also the electrification of buses. Currently, CRUT operates 50 e-buses that are scheduled from two depots in the city. Further expansion of e-bus service is also on the anvil. (see Graph 5: Trend in bus numbers, ridership and bus routes in Bhubaneswar).

Moreover, CRUT Bhubaneshwar has adopted an innovative strategy of connecting bus service with the three wheeler feeders and connected Mo-buses with 50 autos for last mile connectivity to neigbourhoods of the catchment of Mo bus service. There are plans to increase services by adding 500 e-autos by the end of 2023 in several parts of the city.

Further intensification of these services can be a strong enabler for LEZ implementation.

Genesis of the proposed LEZ Area

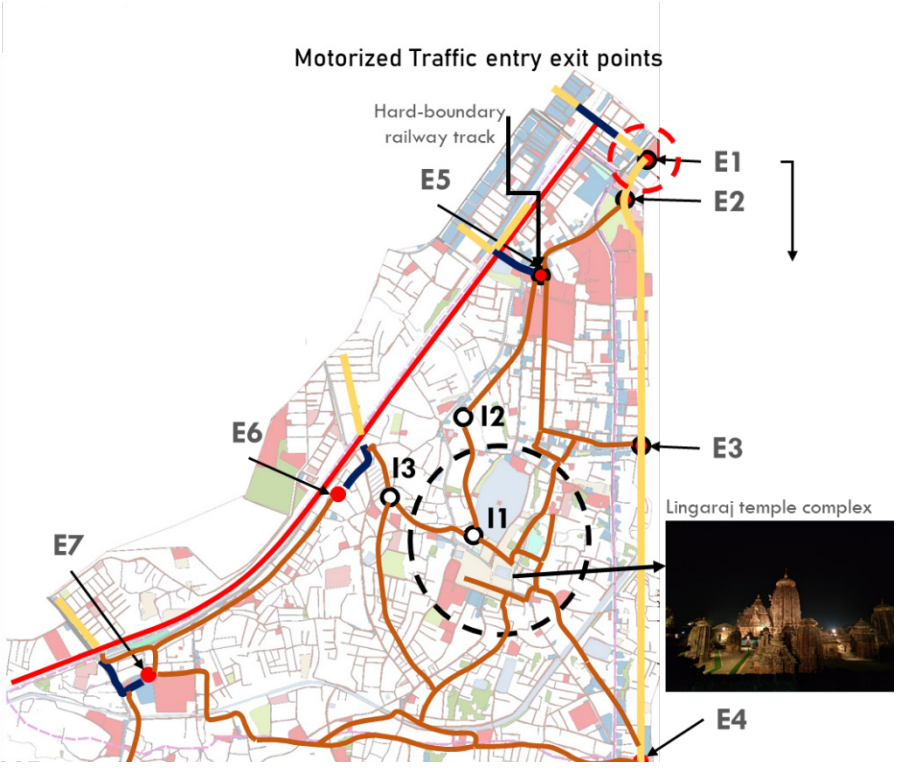
Bhubaneswar has taken steps to moot the idea of LEZ. The State Pollution Control Board (SPCB Odisha) has identified an area of 5.54 sqkm radius around the historical Lingaraj Temple. This is a point of domestic tourism that also has a

mix of residential areas, hospital, colleges, and commercial establishments among others.

Visit to this area shows that this is bounded by railway track on western side and Lewis road on the east. Mapping of the activity areas suggests that there are 7 major and 21 secondary entry and exit points to the area. It has 8 intersections of which only one major intersection is signalized. Four entry points have fly-over and over-bridges. The LEZ needs to be broken down into core, intermediate and periphery to develop separate pricing/restriction mechanisms for each category to phase in the plan.

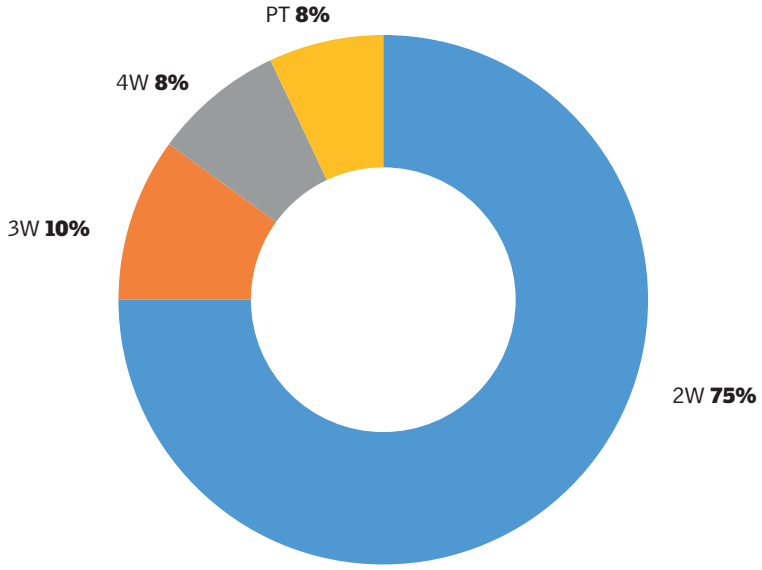
This mapping needs by local surveys of traffic circulation, ownership and usage pattern, willingness to shift, stakeholder consultation etc. This requires deeper engagement with the urban local bodies and other implementing agencies, local residents and a range of stakeholders. Designing of local interventions will require a strong interface with the larger policies and regulations at the city level. (see Figure 5: The proposed designation of LEZ area).

Figure 5: The proposed designation of LEZ area



Source: CSE assessment

Graph 6: Share of vehicle segments as per the traffic count in major entry points to the LEZ



Source: CSE assessment

To get a diagnostic idea the CSE has conducted a rapid traffic count in four key entry points to the delineated area. It shows that the identified area witnesses high movement of two-wheelers. Data also suggests that only 6-7 per cent trips are on public transport buses. Three-wheelers and buses together are 17 per cent of the count. About 8 per cent are four wheelers (see *Graph 6: Share of vehicle segments as per the traffic count in major entry points to the LEZ).*

This indicative data suggests that if LEZ is implemented two-wheelers can be the priority target for electrification and shifts to sustainable modes of public transport. And three wheelers can be mandated to renew the fleet based on electric models.

Clean air action and role of the State Pollution Control Board (SPCB): The SPCB, Odisha, has taken the lead to develop this concept strategy as part of their clean air action. The SPCB officials perceive this as a strategy to mitigate growing air pollution in the city, reducing growing emissions intensity from vehicles and combating the rate of motorization. Expert consultation and support from GIZ have helped to take forward the concept and institutionalise the process.

The SPCB has leveraged the state tourism plan and the Heritage policy. The tourism plan provides for area improvement of targeted monuments of importance. One of them is the Lingaraj temple in Bhubaneswar that attracts considerable domestic

tourists. The tourism plan in any case requires local area improvement around the temple and reorganisation of parking and traffic circulation and improvement in connectivity of the area. This has been taken as the basis to expand the core area and broaden the scope of application.

Studies and local area assessment have been initiated to develop the LEZ plan for implementation. It is likely that this approach may consider vehicles and few other local sources of pollution in the area like waste burning. Actual details are not available. It is said that at this concept stage plans are being contemplated to regulate the entry of vehicles powered by internal combustion engines and promote vehicles on clean fuels and electric vehicles. The local residents may get identification stickers for their vehicles. The objective may also be to improve public transport connectivity and intensify charging stations network, and restrain personal vehicle dependency.

The legal underpinning for this work can be drawn from the National Clean Air Programme (NCAP) that has mandated implementation of clean air action plan in Bhubaneswar. In fact, the SPCB can leverage the Environment Protection Act 1986, and the Air (Prevention and Control of pollution) Act 1981. The Air Act 1981 provides for declaring critically polluted areas for more purposeful action.

In addition, the Clean Air Action plan and micro action plan for Bhubaneswar under the NCAP programme has provided for augmentation of public transport services, expanding infrastructure for walking and cycling, implementing measures like parking policy as a vehicle restraint measures and electric vehicle policy for zero emissions transition. All of these provisions can be integrated and further enhanced with supportive congestion pricing etc to implement LEZ comprehensively.

The idea is still at a planning stage and not integrated with the larger institutional process of the government. Once the concept plan is finalised this can be put through the institutional process. That would require creating a mandate by the state government and initiation of interdepartmental coordination to put in place an implementation process.

How do stakeholder departments need to engage?

Currently, there is no detail available with regard to the exact scope of application and the level of regulations to be introduced in the zone with respect to restrictions on entry and exit of vehicles based on their level of emission standards and zero tailpipe emissions, entry charge, rules for the local residents inside the zone like

fleet renewal and phase out of old vehicles etc. There is therefore no firm official notification or order on this. Yet recognising the importance of the strategy and its potential application, a few key departments were consulted to understand the perception, role and preparedness of the key departments for potential application of such a concept.

Perception of the transport Department: The transport department deals with a few critical strategies that have bearing on the implementation of the LEZ. These include phase out of old vehicles, scrappage of end-of-life vehicles and scrappage incentives and state electric vehicle policy including the scheme to incentivise government officials to purchase electric vehicles. Also under the Central Motor Vehicles Rules 1988 and the Central Motor Vehicles Rules (CMVR) 1988, multiple provisions can enable implementation of LEZ. For instance, section 115 of the Motor Vehicles Act, 1988 gives power to the state to control traffic, restrict use of vehicles, in the interest of public safety or convenience.

At this stage the department is not yet aware of the LEZ strategy. But they agree that an area based approach to pollution mitigation is possible and efforts can be made to intensify targeted implementation. Within the ambit of the authority of the department it would have to be explored how various functions and programmes related to vehicle scrappage, electric vehicle programme, vehicle taxes, and network of charging stations can be targeted in a zone that are locally appropriate. This strategy will also require upgrading the on-road emissions monitoring with remote sensing monitoring for improved profiling of real world emissions from on-road vehicles and go beyond the PUC programme.

The key enabler will have to be a government order to notify implementation of LEZ.

Perception of municipal corporation: The Bhubaneswar Municipal Corporation (BMC) has already taken the lead to develop infrastructure for walking and cycling in the city, street scaping and implement planned vending zones on footpaths and also frame a draft parking policy with area management approach. Refining these strategies for adapting to the requirements of LEZ should not be a problem.

The BMC officials convey that such a strategy is doable but a state mandate is needed to initiate the process. There are legal instruments that can be leveraged to take this forward. It is also evident from expert consultation that the municipal Corporations Act has multiple clauses that empowers city authorities to restrict vehicle movement in identified areas of public interest, to prevent danger,

obstruction or inconvenience to the public. Such a provision can enable LEZ action. Street design guidelines exist and can be further informed by the Sustainable Habitat (NMSH) parameters etc. Also under the Town and Country Planning Act, a city master plan can be framed addressing the requirements of LEZ. If the city decides to implement transit oriented development along the key arterial and bus routes LEZ can be planned in the influence area to promote public transport usage, improve accessibility, design complete streets meeting the requirements of all road users, improve public spaces, street management, parking as a demand management tool including differential pricing and parking cap.

A government order to notify implementation of LEZ can enable the process.

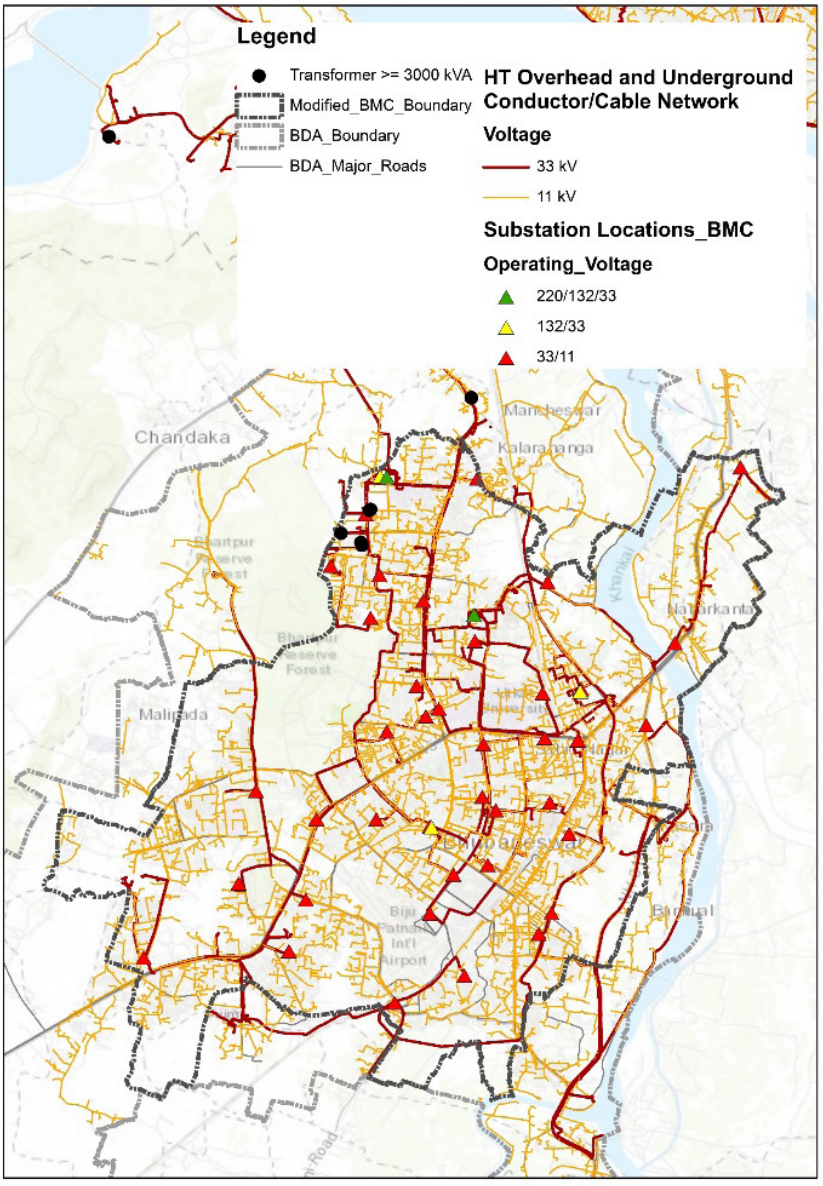
The Capital Region Urban Transport (**CRUT**): The public transit agency is responsible for providing and expanding bus services in the city and nearby region. CRUT is augmenting bus service including e-bus service. This has helped to increase bus ridership. Already significant expansion of Mo bus service has happened in the city.

According to the CRUT officials planning for enhancement of services for targeted zones is possible depending on the nature of demand and potential shift to buses. Bus ridership can be further augmented by improving last mile connectivity strategies. In fact, CRUT has taken the lead to initiate a scheme of introducing electric autos to integrate with the Mo bus routes and connect the neighbourhoods in the catchment. The current fleet of 50 electric autos are expected to be increased to 500. This can be further leveraged if there is a LEZ.

If there is a mandate for implementation of LEZ, customising the services to meet the requirements of the zone should not be a challenge. There is also adequate legal handle that can be aligned and leveraged. These include state EV bus adoption target as per the Odisha state Electric Vehicle Policy, clean air action plan for the city and the requirements of LiFE Mission action that has emphasised the usage of public transport.

Linking LEZ with fleet electrification and charging infrastructure in potential LEZ: LEZ is an opportunity to quicken the uptake of electric vehicles in the zone and its catchment in the city. This can be leveraged to promote zero emissions electric vehicles. A lot will depend on the way the LEZ will be designed to create opportunities for electric vehicles. The composition of vehicle stock in the targeted zone around the Lingaraj temple is dominated by two-wheelers with reasonably high usage of three wheelers. A targeted replacement of these vehicles with

Figure 6: Current power grid in Bhubaneswar



Source: Tata Power Bhubaneswar

incentives can speed up electrification. Lower operational costs and competitive total cost of ownership that is evident from the national review and local market can aid in rapid change over of the market with targeted regulatory push.

To support this transition, expansion of public charging facilities including battery swapping facilities and increasing home charging facilities (more suitable for two

and three wheelers) can be a game changer. Such planning can be done by the transport department Bhubaneswar Municipal corporation with support from the DISCOMs and charging providers. Engagement with the local Discoms like Tata Power in Bhubaneswar suggests that at this moment, electric vehicle adoption is slow and these have not yet generated high demand pressure. But the current grid can support further intensification of demand from electric vehicles at least for the next five years.

Once the mandate for LEZ is in place targeted electrification of two-and three wheelers in the initial phases can be accelerated in the targeted zone and in the catchment. Also given the fact that electric bus service is expanding in the city, intensifying electric bus service in the zone is also possible. As a combined strategy this can lead to significant reduction in local pollution and energy intensity of vehicles and mass commuting.

The way forward

As Bhubaneswar takes the lead and the concept is also gaining ground in other cities like Delhi and Pune, it is necessary to lay out the key steps and build on the insights from the ground. This strategy would need to be designed to reduce emissions from vehicles, speed up transition to clean and zero emission vehicles, promote public transport usage, and improve accessibility of the area for all road users. This is an opportunity to tie all key mobility transition initiatives including accessibility, improved connectivity, public transport strategies, vehicle restraint measures and fleet electrification in an integrated framework for implementation in delineated areas of the city that can also have much wider influence in the larger catchment of the city. However, such a strategy will require a few prerequisites for effective implementation.

Define the mandate for implementation of LEZ: There is a need for a clear mandate from the state governments for implementation of LEZ. That it needs to be backed by administrative or legal order outlining the roles of the concerned departments by fixing responsibilities. As several approaches are needed for implementation of LEZ, different departments will have to come together to implement in coordinated way the entry regulations for different types of vehicles; entry charges as per the emissions and congestion potential of vehicle segments; electrification of vehicle fleet, enhance public transport and paratransit services and related infrastructure including passenger information system and improved frequency; targeted scrappage policy and incentives for fleet renewal; adequate charging infrastructure; street redevelopment plans for improving accessibility; implementation of parking management area plans as a demand restraint measures among others.

Defining the scope of the LEZ programme: Cities embarking on this programme need to decide the scope and parameters to design the LEZ programme. This is expected to be widely diverse across cities depending on the local requirements. There are widely differing views from considering only vehicular pollution and accelerating electrification of the fleet to other sources of pollution. However, addressing vehicular pollution and transitioning to electric vehicle programs along with improved accessibility and connectivity will be central to this strategy.

Identification of the target areas in cities: The urban development departments, urban local bodies and SPCBs need to identify the areas where the LEZ can be implemented, considering factors such as pollution and congestion levels,

population and vehicle ownership patterns, profile of the vehicle fleet, transit traffic volume etc. The size of the cordoned area, its demographics, impact area, and composition of residential and commercial areas, composition of vehicles, pedestrian footfall, connectivity need to be surveyed and measured. Globally, the focus has been on congested and polluted city areas and heritage areas that attract a lot of tourist traffic.

Different parts of the city may qualify to be a Low Emission Zone based on different qualifying criteria. For example, these may include historical centres of tourist importance, commercial areas with high footfall, multi-modal hub etc that can be prioritised.

Need indices and data for profiling vehicle stock in the area for regulating vehicular movement: Local surveys are needed to assess the distribution of vehicles by fuel, age and weight to design the programme. Such profiling can help to identify vehicle categories to be targeted, dominant emissions standard of the fleet, fuel consumption, emissions profile and more.

Assessing local air quality and emission levels of different genres of vehicles to regulate vehicular movement based on emissions standards: As the overall purpose is to reduce local exposures to vehicular pollution it becomes necessary to achieve faster fleet renewal by replacing or restricting movement of older vehicles that meet outdated emissions standards. Often such schemes insist on providing preferential incentives for zero emissions vehicles or vehicles meeting the latest emissions standards. The objective is to reduce particulate matter, nitrogen oxide, among others. This can be further enabled by introducing more advanced remote sensing monitoring in the city that can profile the emissions levels of a much larger fleet size help to identify the gross polluters and the worst emitters that can also be selectively eliminated.

Improve on-road emissions monitoring and measurement techniques to aid in implementation of LEZ: Globally, there is growing interest in application of remote sensing measurements in generating real world emissions data from on-road vehicles for fleet profiling. That helps to characterise emissions of different genre of vehicles by fuel, age, technology vintage etc and identifies the worst emitters on the road. Such assessments carried out under The Real Urban Emissions Initiatives of the FIA Foundation have brought out the profile of real world driving emissions in several cities including London, Paris, Berlin, Jakarta among others. The remote sensing devices are installed on the roadside for Real Driving Emissions (RDE) tests that can measure emissions instantaneously from

vehicles passing by. These can measure gaseous pollutants including NO, NO2 and CO etc. These can be benchmarked to identify the worst emitters. This can help with screening of vehicle emissions to identify high or low polluting vehicles and vehicle types under specific driving conditions. Such evidence also helps to build support for the programme when the high level of on-road emissions are transparent. India needs to make this strategic transition and go beyond the current pollution under control certificate (PUC) programme.

Profile the vehicular ownership pattern and differential impacts of LEZ restrictions on income groups to plan exemptions and incentives in the LEZ: It is necessary to assess the differential impacts of the scheme on local residents. It is important to classify exemptions depending on predefined criteria and to minimize the impact on the vulnerable communities. Globally, LEZ is controversial as it is also seen as unfair restrictions to penalize drivers of older vehicles who may not be able to afford to upgrade to more environmentally friendly models. This matter has also come up in cities that have attempted to phase out older vehicles. Questions have been raised about its impact on older people and limited income groups who may find it difficult to replace vehicles. Moreover, in Indian cities vehicle ownership is dominated by two-and three wheelers that are different from global cities. Both exemptions and incentives will have to be informed adequately.

Planning for EV deployment is necessary for an LEZ: This is needed to ensure adequate infrastructure enabler for low emission vehicles within the area. Building complete streets act as an enabler to LEZ. Complete streets encourage people to walk, cycle and socialise on streets. This can be a conducive environment to promote LEZ in identified zones in a city. Implementation of LEZ involves a complex set of factors as this has to deal with a diverse set of dynamic situations in the local setting.

Prioritizing pedestrian movement and access to public transport: As the LEZ operates as a vehicle restraint measure with a range of restrictions by type of fuel, age, pollution potential etc, each LEZ will require public transport accessibility assessment and well- designed infrastructure for pedestrian movement, last mile connectivity and improved multi-modal integration. If an LEZ is identified within a tourism network, it is important to identify routes for intermediate transport, routes for e-vehicles etc. to allow movement. These need to leverage all the legal provisioning of transit oriented development, tied metro funding for walking and cycling infrastructure and feeders, street design guidelines, parking policy etc.

Strategy for incoming traffic and other modes of transport in LEZ: This will also require a strategy for the vehicular traffic originating outside the zone as their

entry into the zone will be regulated based on their emissions levels. This will have implications for the larger catchment area in the city. Specific strategies are needed to regulate movement according to the duration and time of the day depending on the peak and non-peak hours, congestion and emission levels etc. This will also influence a larger catchment and also a range of other transport including aggregators, buses, and paratransit. This will require an interface between the LEZ policy and the city wide policy on setting targets for overall improvement in emissions standards, fleet renewal and electrification.

Identifying key stakeholders and engaging with them in the planning process: The success of LEZ will require local public support and participation of the concerned departments. LEZ development involves multiple stakeholders. Identify and classify roles and responsibilities of all stakeholders. There must be a regular timeline for interaction and engagement with all stakeholders while working towards LEZ implementation. This requires sensitizing the residents about the plan, its differential impacts, efforts to improve overall accessibility and connectivity to the area, public transport infrastructure, vehicle charging infrastructure etc. This requires a detailed mitigation strategy.

Develop local area plans and introduce other demand management measures like parking caps and pricing as a prerequisite: Restrictive action on vehicular movement cannot be enforced overnight in isolation. This needs to be supported by a range of other demand management measures and urban planning measures in the area. As the restrictive action on vehicles requires scaling up of local mobility options, it is necessary that detailed plans are made based on mapping of local activities, road users, multi-modal integration of points and facilities, allied traffic, pedestrian and local circulation plans, parking caps and parking pricing strategy etc. These are prerequisites for establishing LEZs. A range of demand management measures including parking need to kick in.

Establish enforcement and compliance mechanisms: Establish enforcement mechanisms to ensure compliance with the LEZ regulations, such as fines or penalties for non-compliance. This will also require an intelligent transport system and camera based smart monitoring. Fines and penalties are commonly used to enforce compliance with the LEZ regulations. This can include daily fees for non-compliant vehicles, fines for repeat offenders, and suspension of vehicle registration. Automatic number plate recognition (ANPR) cameras need to be used to read the number plates of vehicles entering the LEZ. The cameras can identify whether the vehicles meet the required emissions standards or not, and fines can be issued automatically to non-compliant vehicles.

Monitor and evaluate implementation: Establish a system to monitor and evaluate the effectiveness of the LEZ, including monitoring air quality levels, tracking the number and type of vehicles entering the LEZ, and evaluating public perception and compliance with the regulations. This will also require adoption of more advanced monitoring of real world driving emissions based on remote sensing measurements to inform the LEZ process. This will also require assessment of local air quality with real-time air quality monitoring systems, signage to indicate the boundaries of the LEZ etc. On-road inspections involve spot checks of vehicles entering the LEZ to ensure compliance with the emissions standards

Invest revenue from permit/entry fees for local area development. This is needed to build public support for the LEZ strategy. People will volunteer to support such schemes if they see direct benefits flowing back in their zone. This requires a local area improvement plan and investment in local infrastructure for walking and cycling, and other facilities for local area improvement.

Timeline of implementation: LEZ concept is likely to include several strategies for phase in with milestones. These need to be implemented according to a timeline. There need to be a clear set of guidelines with a timeline for transition and to encourage more and more people to comply.

Exemptions and permits to mitigate the impacts of the LEZ restrictions: Given the differentiated and disproportionate impact of LEZ provisions on the local community, a combination of permits, exemptions and incentives may have to be worked out to minimise the impacts. Some LEZs may provide exemptions or permits for certain types of vehicles or for vehicles used for specific purposes, such as emergency vehicles or public transit among others.

Education and outreach: It is quite likely that there might by a lot of disinformation and myths around these new generation measures that might lead to local or even city-wide resistance. This is evident from global experience. Education and outreach is needed to inform drivers/residents about the LEZ, its requirements and its benefits. This can include public information campaigns, signage, and outreach to businesses and residents in the LEZ. It is necessary to plan public outreach and education efforts to promote awareness of the LEZ and its benefits, as well as to educate residents and drivers about the regulations and compliance requirements. It is important to establish a clear enforcement strategy for the LEZ and to communicate this to the public. This can help to ensure that the LEZ is effective in improving air quality and reducing emissions.

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Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
Website: www.cseindia.org