ITES
Part of the UK-India Net Zero Innovation Virtual Centre

Clean Air Zones:

Learning from the experience of roadside emissions

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CATAPULT Energy Systems

Contents

1 Introduction

Policy and regulation have a crucial role in supporting decision making for innovators and investors. Good policy and regulation provide a credible long-term framework for innovation that works by:

- Sending clear signals that give investors confidence.
- Helping innovators target innovation more effectively.
- Identifying opportunities for collaborative partnerships to kick start innovation.
- Helping markets to develop and reveal innovative solutions that work best for consumers.

Through our Net Zero Carbon Policy Thought Leadership project[1], the Energy Systems Catapult has proposed a whole systems approach to decarbonising the UK economy that considers the regulatory and policy framework required to encourage innovation towards sustained decarbonisation, decoupled from economic growth.

In this short report we review the UK's response to roadside emissions to improve urban air quality. Drawing on our principles for Net Zero Carbon Policy design we will review the development and implementation of the Clean Air Zones (CAZ) and alternative proposals.

This report was commissioned on behalf of the Innovating for Transport and Energy Systems (ITES) initiative to help ascertain the role CAZs could have in both reducing urban air pollution and encouraging the decarbonisation of the road transport sector in India. The report will therefore consider the suitability of a CAZ or similar scheme for India.

1.1 Considerations for developing policies to address roadside emissions

We recommend the following high level policy principles for policy development at the Energy Systems Catapult. For the purposes of this report, these principles have been adapted to consider the transport focus of roadside pollution:

[1] Energy Systems Catapult Net Zero Carbon Policy https://es.catapult.org.uk/project/net-zero-carbon-policy/

- Make the system work for transport users – understanding transport needs and behaviours, from commuters to businesses to maximise the benefits of large-scale investment in the transport system.
- Adopt a whole systems approach to policy design – considering all parts of the physical system (including the energy system and transport infrastructure), the needs of all end users (including commuters and businesses) and how the whole system is controlled and shaped by policy, markets and digital arrangements. A whole systems approach also recognises the value of experimental policy design, using sandboxes, to test innovative policy scenarios.
- Implement technology agnostic incentives to encourage outcome-based innovation such as fuel efficiency and emissions reduction, enabling markets to reveal the most innovative solutions and drive long-term demand for low emission vehicles.
- Recognise the value of place-based planning and partnerships incorporating local and sector specific insights to support local opportunities for growth and efficiencies.
- Provide clear guidance to sectors and stakeholders – help transport users make informed choices about the modes and vehicles most suited to their needs and business models. Long-term policy signals are particularly important for assets requiring long-term investment, such as heave goods vehicles and business fleets.
- Adopt a transparent and adaptive approach to data analysis, ensuring progress is not only measured by easy-to-model centralised policies and estimated emissions. Doing so risks neglecting the importance of policy enablers such as targeted investment in infrastructure.

1.2 Air quality in India

India has undergone a period of rapid growth in private vehicle ownership. In additional to private cars, two-wheel motorcycles and mopeds (M2W) are a very popular form of travel in Indian cities. In response, the Indian government has prioritised air pollution measures in its largest metropolitan cities: Chennai, Delhi, Kolkata, and Mumbai[2]. Public transport was mandated to be run on CNG by March 2001 and ongoing initiatives include regulated vehicle standards and fuel taxes.

[2] Jabbar et al (2022) Aur Quality, Pollution and Sustainability Trends in South Asia: A Population-Based Study. International Journal of Environmental Research and Public Health. Volume 19.

India's policy response is comparable to policy responses in Europe, with several acts of legislation setting standards on vehicles, fuels and pollutant levels (Figure 1). However, government intervention has been unable to keep pace with the rapid urbanisation and uptake in vehicle use. Over the last three decades the number of motor vehicles in India doubled compared to a 2-5% growth rate in Canada, US, UK and Japan[3]. In Delhi, between 1971 and 2011 the road length increased by almost four times (from 8380-31,969km), whereas the number of registered vehicles increased by 20 times, leading in an increase in congestion and air pollution[4].

Like the UK, India uses an Air Quality Index (API) to communicate and forecast the severity of pollution in major cities. Pollution levels in Delhi have been severe enough receive attention from the Indian Supreme Court and several measures, such as closing schools and banning HGVs from the city have been attempted. However, enforcement over such a large, populated area has proved challenging.

Like Europe, India has its own form of vehicle emissions standards – the Bharat stage emission standards (BSES) – which are issued at the national government level. Bharat Stage IV is equivalent to EURO IV and a phased approach to vehicle standard, increasing in standards, has been applied since 2010 in 13 major cities, including Delhi[5].

1.3 Air quality policy in the UK

The UK has a long history of managing and regulating air pollution. The first Clean Air Act was introduced in 1956 and smoke control areas were imposed in major UK cities throughout the 1960s to reduce smog events. Throughout the 1970s and 1980s, additional policies were introduced to target industrial pollution, including international treaties to address transboundary pollutants such as acid rain.

Transport related emissions became more of a focus for the UK and the European Union (EU) in the 1990s and 2000s, with the bulk of emissions reductions during that time coming from improvements in fuel quality. In 1995, the UK's Environment Act introduced a statutory requirement for local authorities (LAs) to respond to urban air pollution. The Act was in response to increasing concerns around the prevalence of

[3] Neeta and Geeta (2013) Air Pollution Due to Road Transportation in India: A Review on Assessment and Reduction Strategies. Journal of Environmental Research and Development, Volume 8 Issue 1 P69-77

[4] Gurjar, Ravindra and Nagpure (2016) Air Pollution trends of Indian megacities and their local-global implications. Atmospheric Environment. Volume 142, p475-495

[5] Gurjar, Ravindra and Nagpure (2016) Air Pollution trends of Indian megacities and their local-global implications. Atmospheric Environment. Volume 142, p475-495

childhood asthma in UK cities. LAs were required to meet newly legislated targets on a range of pollutants, including NO_2 through the implementation of Local Air Quality Management Areas (LAQMs).

PRE-INTERNET ERA (1905-1989)	• 1905 – Bengal Smoke Nuisance Act • 1912 – Bombay Smoke Nuisance Act • 1923 – Indian Boilers Act • 1934 – Indian Petroleum Act • 1939 – Motor Vehicle Act • 1948 – Factories Act • 1963 – Gujarat Smoke Nuisance Act • 1974 – CPCB & SPCBs under Water Act • 1981 – Air (Prevention & Control of Pollution) Act • 1982 – Air (Prevention & Control of Pollution) Act • 1982 – National Ambient Air Quality Standards • 1983 – Air (Prevention & Control of Pollution) (Union Territories) Rules • 1986 – Environment (Protection) Act • 1987 – Air (Prevention & Control of Pollution) Amendment Act • 1988 – Motor Vehicles Act
TRANSITION ERA (1990-1999)	• 1994 – Revised Air Quality • 1994 – Environmental Impact Assessment Notification • 1995 – National Environment Tribunal Act • 1997 – National Environment Appellate Authority Act • 1998 – Environment Pollution Control Authority (EPCA)
INTERNET ERA (2000-2020)	• 2006 – Environmental Impact Assessment Notification • 2009 – National Ambient Air Quality Standards • 2010 – National Green Tribunal Act • 2017 – Graded Response Action Plan (GRAP) • 2019 – Motor Vehicles Act • 2019 – National Clean Air Programme (NCAP) • 2020 – Commission for Air Quality Management (CAQM)

Figure 1: Timeline of Indian Air Quality Policy Development from Gulia et al 2022

In 2005, the UK introduced vehicle taxation bands based on CO_2 emissions to encourage the uptake of lower emission vehicles that adhered to European Vehicle Standards. Whilst not directly an air quality policy, it was originally expected that this approach would help address both GHG emissions and local emissions. However, the policy's focus on CO_2 encouraged an increase in diesel vehicle ownership in the UK[6], which did not reduce NO_2 emissions. The scheme has since been revised to consider different fuel types in addition to CO_2 emissions.

In the 2000s, the UK's national targets were superseded by limit values introduced by the European Commission. For example, the annual mean limit of NO_2 was set at 40µg/m^3 under the Air Quality Daughter Directive 2008/EC/50 with a target date for compliance of 2010. This objective proved difficult to meet and in 2015, the UK's Supreme Court instructed the UK government to develop new proposals that would meet compliance "in the shortest possible time". It was under this instruction that the Clean Air Zone policy was designed.

In 2016, the Dieselgate scandal revealed that laboratory-based testing of emissions for vehicle standards were not reflective of emissions from real-world driving conditions. Volkswagen had been found to have installed devices to cheat the laboratory tests. Other manufacturers were found to have also exploited the laboratory test conditions to meet European Vehicle Standards. The efficacy of air quality modelling which had previously relied on estimates from laboratory testing was called into question.[7]

1.4 Monitoring air quality

India set up its first systematic air quality monitoring in 1967 by the National Environmental Engineering Research Institute (NEERI). Only a limited number of cities operate continuous monitoring stations and access to the monitoring data is limited. Delhi and Pune have citywide monitoring networks.[8]

In India, air pollution studies are often reliant on estimates provided from vehicle standards and emission factors – not real-world driving conditions[9]. This is problematic because vehicle maintenance is not consistently adhered to, with many

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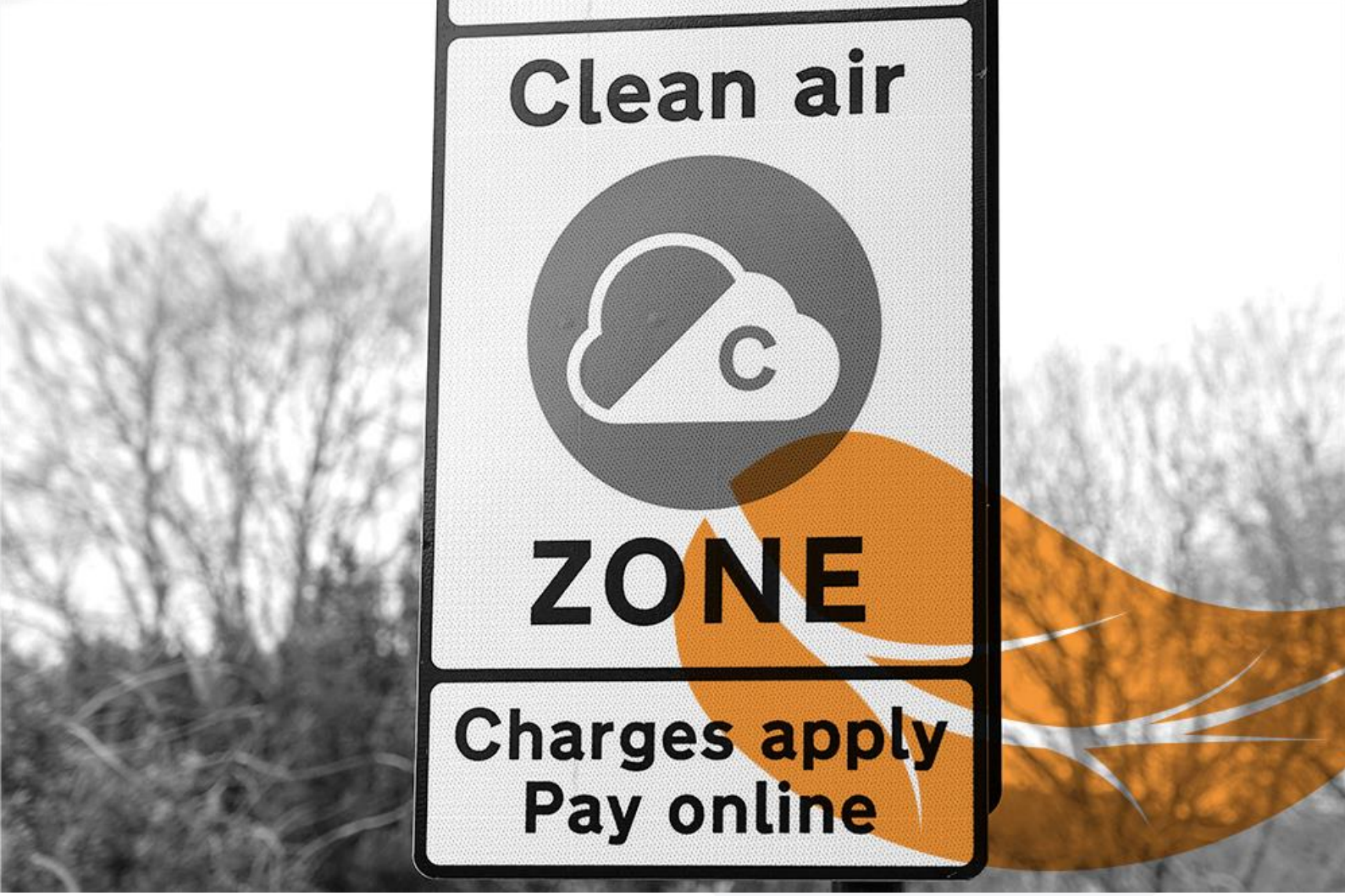
[6] Vehicle Licensing Statistics: Annual 2018 (publishing.service.gov.uk)

[7] Brand, C (2016) Beyond 'Diedelgate': Implications of unaccounted and future air pollutant emissions and energy use for cars in the United Kingdom. Energy Policy, volume 97 p1-12

[8] Guttikunda, Goel and Pant (2014) Nature of air pollution, emissions sources and management of the Indian Cities. Atmospheric Environment, Volume 95, p501-510

[9] Gulia et al (2022) Evolution of air pollution management policies and related research in India. Environmental Challenges, Volume 6



vehicle owners looking to fix their own cars, seeing mechanics as a last resort[10]. Increased real world testing of different vehicle types is required to fully understand the gaps in the existing evidence base.

The UK follows a national methodology for monitoring urban air pollutants. The Automatic Urban and Rural Network (AURN) includes automatic air quality monitoring stations measuring oxides of nitrogen (NOx), sulphur dioxide (SO2), ozone (O3), carbon monoxide (CO) and particles (PM10, PM2.5)[11]. The sites provide high resolution hourly information which can be used to communicate current pollution spikes to the public and vulnerable groups using the UK's AQI.

Automatic monitoring of localised pollutants is costly. Most cities in the UK only have one or two AURN stations to track roadside NO_2 so the location of these stations is very important. Like India, the monitoring of air pollutants in the UK relies heavily on modelling and assumptions. This can make it difficult to respond quickly to changing circumstances such as commuting behaviour changes during the Covid-19 pandemic.

[10] Badami, M (2005) Transport and Urban Air Pollution in India. Environmental Management, Volume 36, Issue 2, pp195-204

[11] UK Air Information Resource https://uk-air.defra.gov.uk/networks/

In some urban areas the AURN monitoring station for NO_2 is not located close enough to a road to make accurate predictions on roadside emissions. For example, in Brighton academics predicted pollution spikes of up to 100ug/m^3 on a main road, but the city was unable to take advantage of funds made available to LAs consulting on CAZs as it was not deemed to be out of compliance.[12]

A much cheaper alternative to monitoring local air pollution is diffuser tubes. These tubes slowly take in air over a longer period, such as a week, and therefore cannot be used to deduce pollution in real time. Comparisons to the AURN station readings are challenging. This makes it difficult for local community groups to prove there are areas they believe to be out of compliance. Innovations to reduce the cost of real-time monitoring or to improve the comparability of diffuser tube and automotive monitoring stations could help empower local communities calling for more intervention in their area.

[12] Lyons et al (2020) Legal but lethal: Lessons from NO2 related mortality in a city compliant with EU limit value, Atmospheric Pollution Research
https://www.sciencedirect.com/science/article/pii/S1309104220300490

2 Clean Air Zones

A Clean Air Zone (CAZ) is an area where specific measures have been introduced to reduce roadside Nitrogen Dioxide (NO2) emissions. First proposed in 2015, most CAZs set out conditions for specific polluting vehicles within a defined geographical zone. Some CAZs contain access restrictions and place charges on specific vehicles for entering a zone. There are also non-charging zones which take other measures to reduce pollution within a defined zone, such as issuing grants to taxi drivers to upgrade their vehicles.

Originally, five cities were instructed to consult on a CAZ for compliance to be met by 2020[13]. In 2017, further guidance was provided, and an additional 23 LAs were instructed to consult on proposals through the Clean Air Zone Framework[14]. However, as of June 2023, only seven charging CAZs have been implemented. Some areas that consulted on a CAZ were able to demonstrate compliance could be met by other, non-charging measures (e.g. Southampton).

2.1 Implementing a Clean Air Zone

The Clean Air Zone Framework provided LAs with four options, or classes, for charging CAZs. Classes of CAZ (see Table 1) increase in severity depending on the extent of pollution in the city, for example if the local authority could demonstrate compliance with the annual mean limit of NO_2 by only charging buses, coaches, and heavy goods vehicles (HGVs) then the local authority did not need to consult on charges to other vehicle types, such as taxis, or privately owned cars.

Class of zone	Vehicles included	Euro standard
A	Buses, Coaches, Taxi's and Private Hire	Euro VI (heavy vehicles) Euro 6 (diesel light vehicles) Euro 4 (petrol light vehicles)
B	As above + Heavy Goods Vehicles	As above
C	As above + Vans and Minibuses	As above
D	As above + Cars. Motorcycles and mopeds are optional.	As above, Euro 3 for motorcycles and mopeds

[13] UK Government announcement (2015) https://www.gov.uk/government/news/improving-air-quality-in-cities

[14] UK Government Policy Paper (2022) https://www.gov.uk/government/publications/air-quality-clean-air-zone-framework-for-england/clean-air-zone-framework

Table 1: Different classes of CAZ. Originally taxis and private hire vehicles were not incorporated into Class A and B, but this was amended in 2020.

Due to the close proximity between UK cities, vehicles could be travelling through multiple zones, so consistency was promoted through national guidelines to improve user experience. This was particularly important for the logistics sector who needed to operate vehicles across multiple zones and factor those costs into their business models.

However, whilst there is consistency between bands, the size of zone boundaries (e.g. Figure 2) varies by location and there is some flexibility in the guidance to allow LAs to set more stringent requirements for specific vehicles. National guidelines have also been adapted since the first cities were instructed in 2015 and in 2017 with the most recent changes published in 2020 so there has been some confusion and frustration amongst stakeholders surrounding the schemes' implementation.

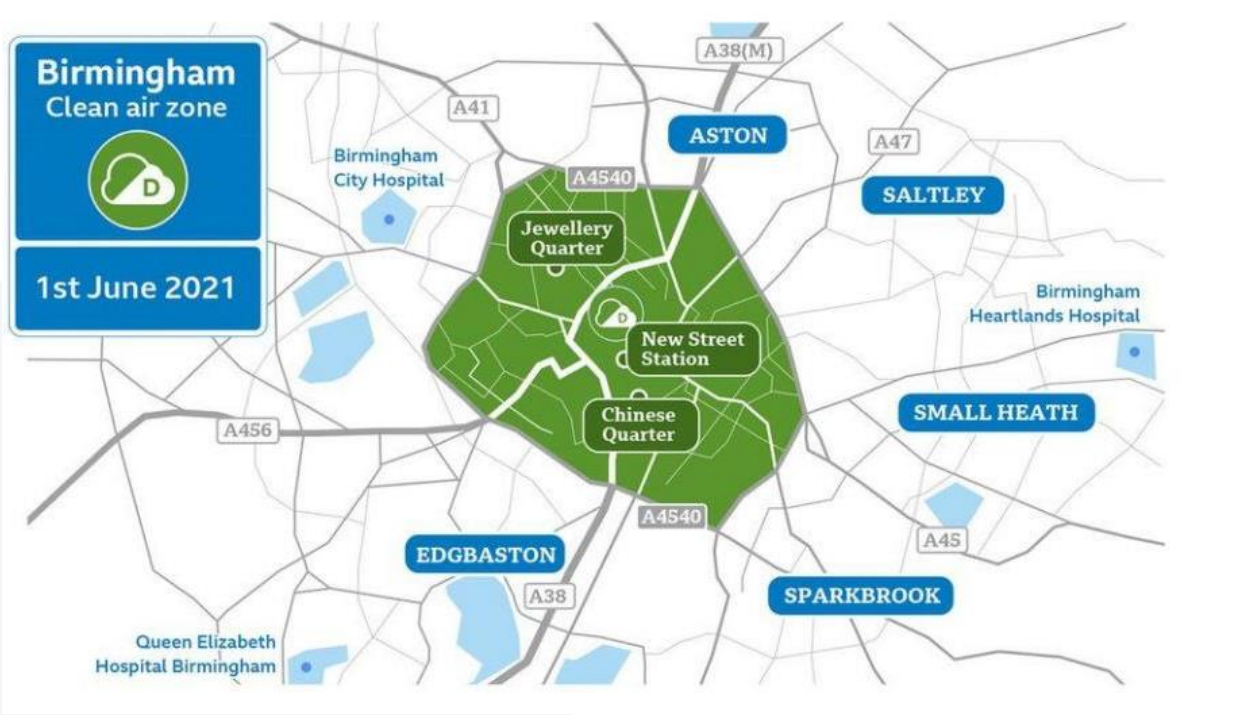


Figure 2: Layout of the Clean Air Zone in Birmingham

2.2 Non-charging Clean Air Zones

In addition to the charging elements of the CAZs, several LAs consulted on non-charging measures to reduce roadside pollution. Some LAs were able to demonstrate non charging measures would help them reach compliance (e.g. Southampton), other

LAs used non-charging measures to reduce the severity of charging measures (e.g. Sheffield). Examples of non-charging measures included:

- **Reducing the speed limit on roads identified as pollution hotspots**. For example, on the A331, a busy dual carriageway on the outskirts of London's commuter belt, the speed limit was reduced from 70mph to 50mph on some sections.
- **Upgrading the vehicle fleet owned by the local authority**. In Southampton, the city council has upgraded 49 vehicles to electric. These vehicles are used by local authority staff. On the outside of the vehicles advertising highlights the scheme to raise awareness to other road users[15].
- **Engine idling campaigns.** Engine idling can contribute to emissions, several LAs ran campaigns to discourage engine idling when vehicles are stationary in traffic or when parked. School groups and community groups also conducted campaigns to raise awareness. However, there is some debate about much of a difference this makes to pollution reduction.
- **Providing grants to affected businesses to upgrade vehicles**, such as taxi companies. In Sheffield, businesses can apply for online grants to upgrade their vehicles. Grants vary depending on the vehicle and include options to retrofit or delicence vehicles (Figure 3).

Your vehicle	A new or Used Euro 6 / Euro 4		A new or Used ULEV		Adapting your existing vehicle (retrofit)	De-licensing
Financial support Type	**Interest Subsidised Loan**	**Grant Only**	**Interest Subsidised Loan**	**Grant Only**	**Grant Only**	**Grant Only**
Camper Van	£4,500	£3,375	£5,000	£3,750	£2,000	
Coach	£16,000	£16,000	£16,000	£16,000	£16,000	
Heavy Goods Vehicle (HGV)	£16,000	£16,000	£16,000	£16,000	£16,000	
Mini Bus (including Private Hire Vehicle 9-16 seats)	£4,500	£3,375	£5,000	£3,750	£2,000	
Motorhome	£4,500	£3,375	£5,000	£3,750	£2,000	
Taxi (hackney)	£6,000	£5,000	£10,000	£10,000	£4,000	£4,000
Taxi (private hire vehicle passenger car)	£3,500	£2,625	£4,000	£3,000		
Taxi (private hire vehicle mini bus up to 8 seats)	£4,500	£3,375	£5,000	£3,750	£2,000	
Van or other Light Good Vehicle (LGV)	£4,500	£3,375	£5,000	£3,750	£2,000	

Figure 3: Table showing grant options for non-compliant vehicles in Sheffield.

[15] Southampton City Council https://www.southampton.gov.uk/travel-transport/find-and-plan/green-transport/electric-vehicles/

2.3 Criticisms of the Clean Air Zones

The CAZ proposal was developed in response to a particular legal breach of the annual mean limit of NO_2 legislated in EU law. Meeting compliance with this objective in identified urban areas created a very narrow focus for the policy's development. Models indicated vehicle upgrades would be the most feasible way to meet compliance quickly with the threshold and therefore the wider transport policy landscape, such as a review of public transport accessibility was not considered as part of the scheme.

The Clean Air Zone Framework has since been amended to include guidance for other urban pollutants and other sources of NOx, such as from boilers. However, the main function of the CAZ is still to penalise certain older vehicles when entering a specified zone to meet compliance with the annual mean limit for NO_2.

The consultation process for a CAZ was extremely lengthy and there was a high degree of criticism from local residents and businesses. The main concerns were around the potential economic impact of the scheme and costs to specific stakeholder groups such as local businesses and taxi drivers. In Southampton, the Association for British Ports (ABP) were vocal in their criticism of the scheme and put forward alternative proposals to mitigate the economic impact on the port[16].

The UK government was criticised for focusing on commercial vehicles and not prioritising privately owner vehicles in their CAZ response. An earlier Carbon Vehicle Tax had encouraged an uptake in diesel vehicles which inadvertently caused a spike in NO_2 emissions. UK government was keen to ensure the public were not penalised for having previously purchased vehicles in good faith. The Road Hauliers Association (RHA) also criticised the scheme for its focus on HGVs and has called for a "CAZ lessons learned" exercise to ensure a more inclusive approach is taken for future proposals to reduce both local and GHG emissions[17].

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[16] Associated British Ports (2018) Cleaner Air for Southampton https://www.southamptonvts.co.uk//admin/content/files/PDF_Downloads/13342%20Associated%20British%20Ports%20Air%20Quality%20Strategy%20Report%20v14.pdf

[17] Road Haulage Association https://www.rha.uk.net/Campaigns/Environment

Several CAZs were also delayed (e.g. Manchester) or cancelled (e.g. Leeds) during the Covid-19 pandemic due to a sudden and dramatic change in commuting behaviours which created uncertainty in existing models[18].

[18] Air Quality News (2020) Clean Air Zones – Postponed or Cancelled https://airqualitynews.com/local-government/clean-air-zones-postponed-or-cancelled/

3 Alternatives to a Clean Air Zone

3.1 Workplace Parking Levy (WPL)

Implemented in Nottingham, a WPL is a charge on employers who provide workplace parking. Employers can choose to reclaim part or all of the cost from their employers to encourage alternative commuting behaviours. Smaller businesses can apply for exemptions. Revenue generated was used to improve Nottingham public transport infrastructure, notably the tram system. The scheme was largely successful because commuters were travelling in from outside of the city and the benefits to public transport infrastructure were popular with local residents. Extensive work was also done to engage businesses early on in the work.

Nottingham is the only city in the UK that has implemented a WPL. The scheme was implemented before the CAZ policy was introduced with the original aim of reducing congestion. When Nottingham was asked to consult on a Clean Air Zone, they were able to demonstrate they could meet compliance with the WPL.

The scheme is appealing to LAs because it provides local source of revenue. Other cities have expressed an interest in the scheme though most proposals were delayed when commuting behaviours changed during the Covid-19 lockdown. Leicester City Council are considering the implementation of a WPL[19] and the Green Party are campaigning for a WPL in Sheffield[20].

WPLs offer an interesting alternative to a CAZ and are worth consideration for Indian cities. The revenue generated goes back into transport infrastructure which is a key policy enabler to encourage commuter behaviour change. Charges could also encourage businesses and employees to collaborate on alternative commuting behaviours, such as carpooling, utilising local knowledge to develop solutions. The scheme would need to be designed in a way that ensures businesses and employees were sufficiently incentivised to change commuting behaviours.

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[19] Leicester City Council (2022) Workplace Parking Levy Consultation https://www.leicester.gov.uk/your-council/city-mayor-peter-soulsby/my-vision/connecting-leicester/workplace-parking-levy/

[20] Sheffield Green Party (2022) Workplace Parking Levy https://sheffieldgreenparty.org.uk/2022/08/15/employers-workplace-parking-levy-frequently-asked-questions/

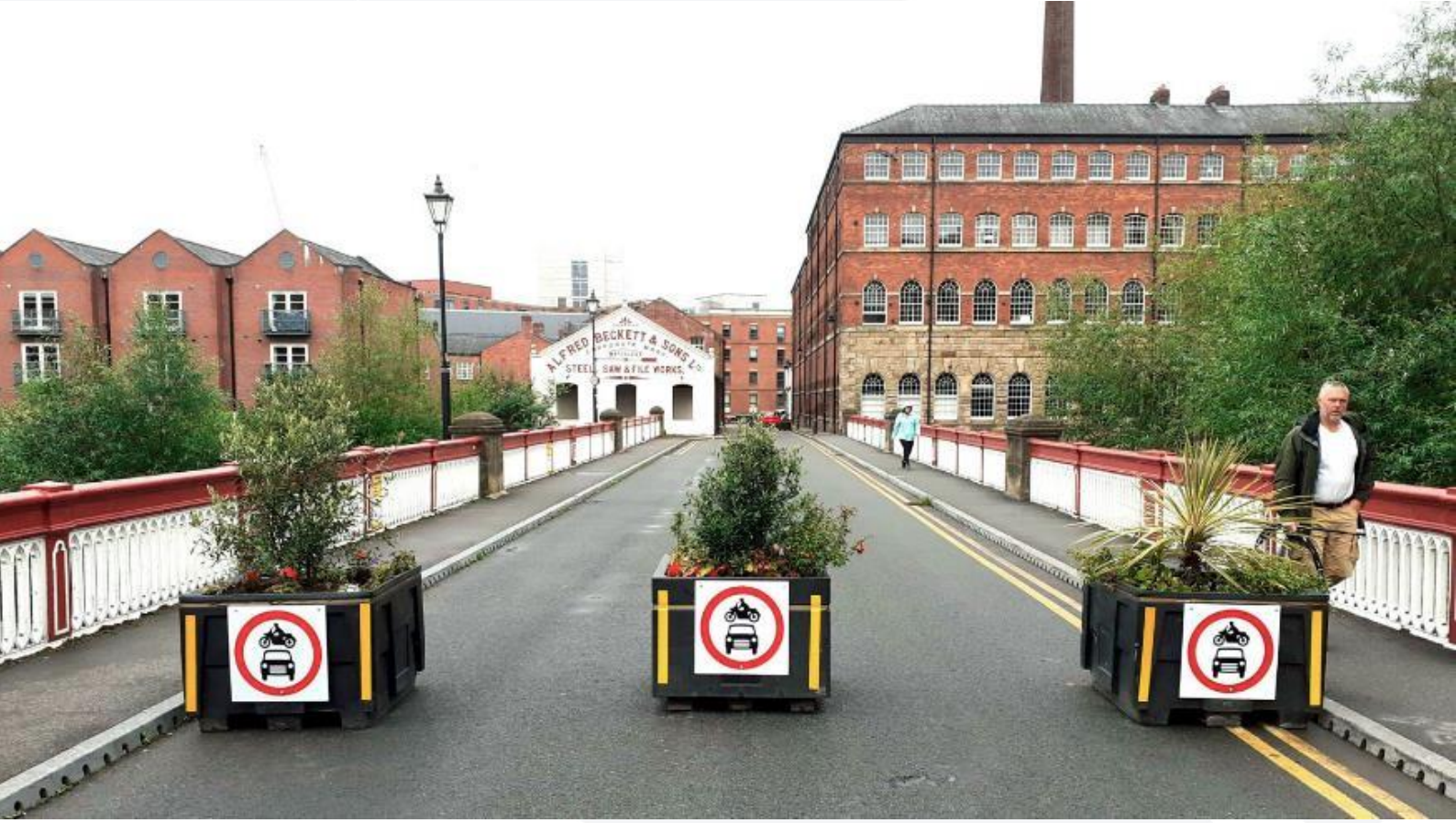

Figure 4: Example of an LTN in Sheffield where barriers have been planted to increase aesthetics of the scheme.

3.2 Low Traffic Neighbourhoods (LTNs)

LTNs are very localised traffic management, usually in the form of barriers to discourage vehicles from using cut throughs to avoid congested main roads. This encourages road users onto main roads which could be targeted with other interventions. LTNs could also be implemented to discourage use at peak times, but in the UK they are usually more permanent structures such as planters (Figure 4).

LTNs are most successful when they have been developed with support from the local community and do not create additional congestion in neighbouring roads. LTNs are usually introduced with a trial period of 6 months to 1 year before with opportunities for residents to highlight their concerns throughout this period. Some LTNs have been reversed after their trial period due to criticism from local road users. However, car free streets have been more popular in other parts of the world, such as Scandinavia[21]. During the pandemic LTNs were also used to support social distancing and enable retailers to use outdoor space.[22]

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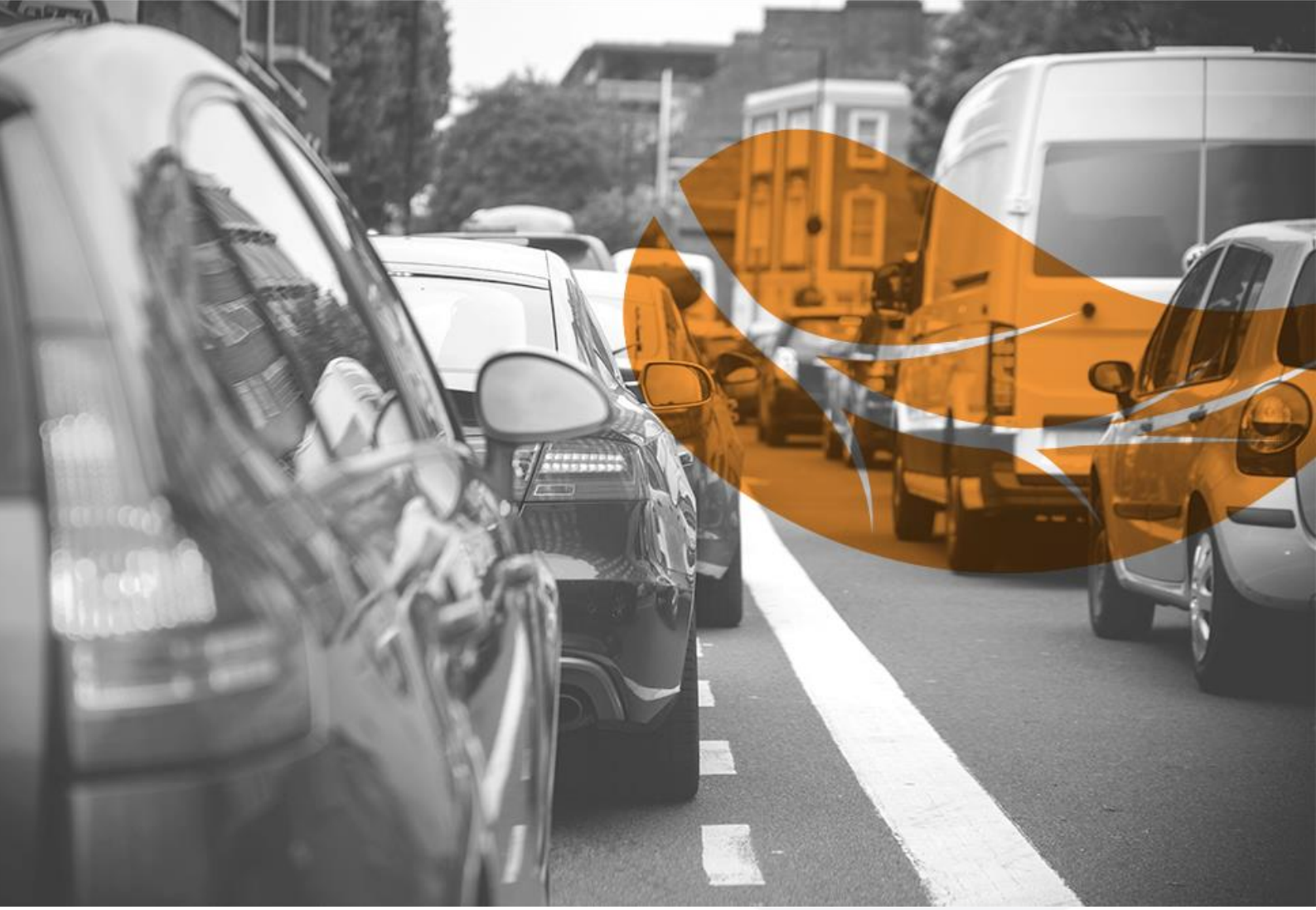
[21] Marcheschi et al (2022) *Residents' acceptance towards car-free street experiments: Focus on perceived quality of life and neighbourhood attachment*. Transportation Research Interdisciplinary Perspectives, Volume 14

[22] Dudley et al (2022) *Low Traffic Neighbourhoods and the Paradox of UK Government Control of the Active Travel Agenda.* The Political Quarterly, Volume 93, Issue 4, p585-593



LTNs could be a useful addition to the policy toolkit to target emissions hotspots. However, LTNs should not be implemented in isolation as they discourage vehicles away from cut-throughs, back onto main roads. Policies will still be required to address pollution and congestion on these main roads. Some LTNs have been implemented through grassroot campaigns, such as from parents from a school on a heavily polluted road and could be an effective way to engage, empower and educate local communities in air pollution and its health risks.

4 Summary

The Clean Air Zone policy was a prescriptive national policy designed to encourage vehicle upgrades by imposing penalties on dirtier vehicles. Critics suggested the policy unfairly penalised businesses and not private vehicle users. Zoned policies also risk moving emissions around not reducing emissions overall.

A CAZ could be implemented in Indian cities with a focus on discouraging private vehicle use, which is increasing in India. However, India has already gone through a significant effort to upgrade buses to CNG and there are already grants available to M2Ws to upgrade.

India has a long track record of issuing standards and discouraging polluting activities through penalties. However, these have not been easy to enforce at the scale required and road users have found workarounds to avoiding penalties. This resourcefulness could be better harnessed where there are clear financial incentives to behaviour change.

Charging vehicle users to enter a zone only discourages this behaviour if there is an alternative more cost-effective option clearly available. CAZs need to be considered alongside improving access to alternative modes of transport, such as public transport. As the public transport system varies across India, a localised approach to planning charging zones would be required. A Workplace Parking Levy may be a more suitable policy to encourage local businesses to collaborate and recognise the value of place-based partnerships and planning.

Opportunities for innovation

The following opportunities for innovation have been identified:

- **Technological developments** – Incentivise businesses and other road users to invest in innovative technology to monitor and reduce emissions, for example:
  - Innovations in vehicle emissions. Policies to reduce emissions from buses across the EU have encouraged significant investment and advances in the electrification of heavy vehicles[23].
  - Innovations to reduce the cost of real-time localised monitoring and improve transparency of local emissions to ensure policies are having a material effect on emissions reduction.

[23] The International Council on Clean Transportation (2022) Rapid Deployment of Zero Emission Buses in Europe https://theicct.org/publication/the-rapid-deployment-of-zero-emission-buses-in-europe/

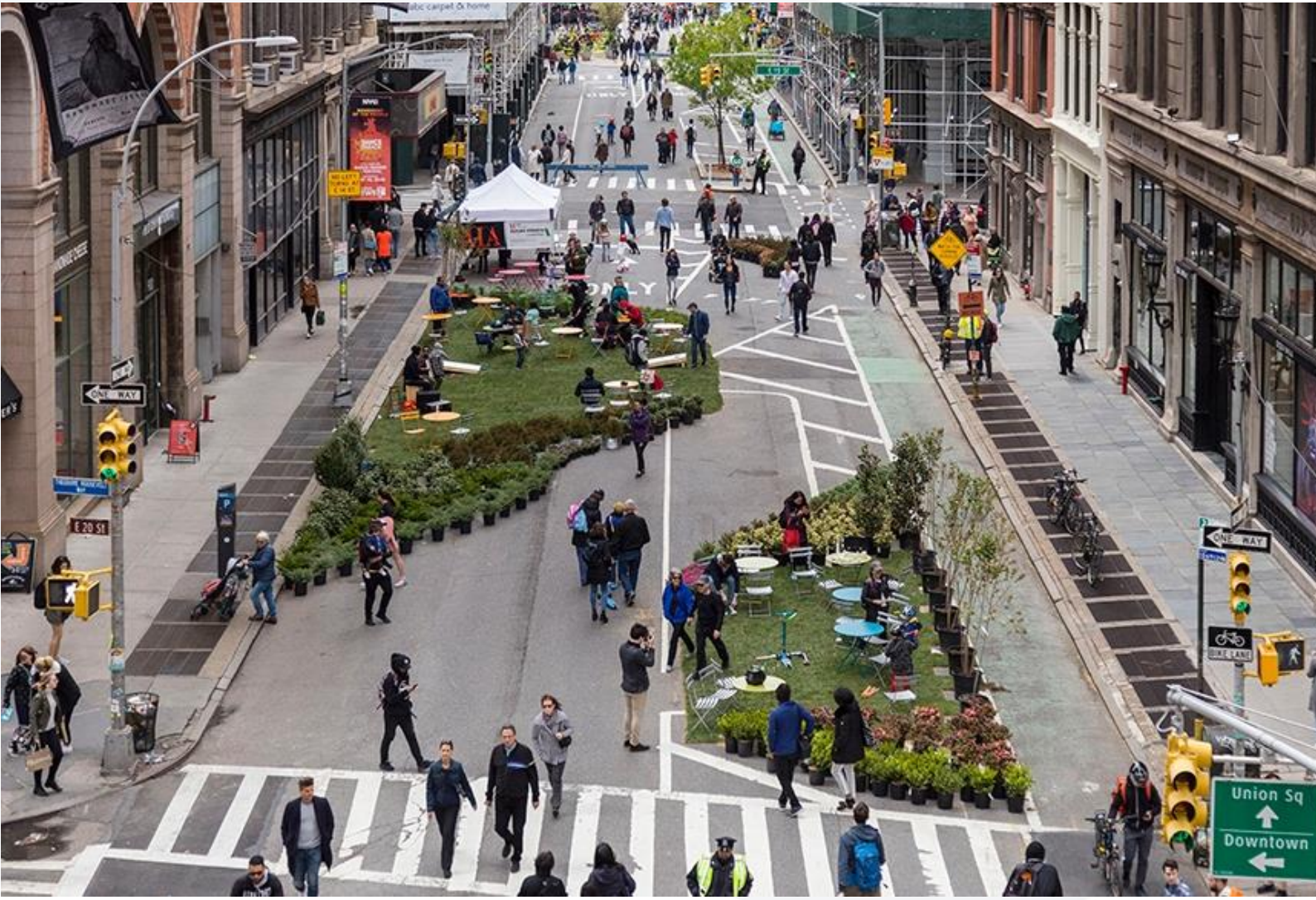


Figure 5: Example of a car free street event in New York 2019[24]

- **Innovative services** – creating a market demand for more accurate and real time monitoring and use of digital applications to increase public awareness and engagement. In addition to encouraging behaviour change, public awareness and engagement can also lead to demand for new technologies, such as personal monitoring devices.
- **Data accessibility** – making air quality data accessible to innovators helps identify opportunities for innovation.
- **Innovative spaces** – There may be opportunities to transform how local areas are used, making some areas car free. Some areas host car-free street events to increase public awareness and promote alternative uses for existing roads (e.g. Figure 5).

[24] New York City Street Design Manual https://www.nycstreetdesign.info/programming/large-scale-annual-car-free-events

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