Low Emission (Clean Air) Zones

Low Emission Zones – also known as Clean Air Zones – aim to achieve compliance with legal air quality objectives by discouraging the use of highly polluting vehicles in urban areas. This briefing note examines current knowledge as to whether these initiatives work, gaps in our understanding and lessons for future place-based air quality solutions.

Overview

- Clean Air Zones and Low Emission Zones aim to discourage the use of the most polluting vehicles, typically in urban areas.
- They are being increasingly introduced by local authorities to achieve compliance with legally binding air quality objectives.
- Many questions remain regarding their effectiveness to improve air quality, health, and impacts on wider society.
- Scientific evidence can be used to inform future place-based air quality solutions.

Background

Air pollution represents the largest environmental risk to health in the UK, responsible for between 28,000 – 36,000 premature deaths each year.[1] Research has linked poor air quality with a wide range of adverse health outcomes including the development of childhood asthma[2], heart and lung disease[3] and cancer[4]; poor mental health[5] and cognitive performance[6] and the onset of neurodegenerative diseases (e.g., Alzheimer's)[7]; and poor birth outcomes.[8] This places significant financial burden on the NHS and national economy; in 2017 the total NHS and social care cost due to air pollution exposure is estimated to be up to £157 million[9], and the wider economic costs to society are estimated to be £20 billion per year.[10] The health effects of air pollution are disproportionately borne by those of lower socio-economic status and minority ethnic groups, who are exposed to higher levels of air pollution[11,12], and are more likely to experience pre-existing health conditions that make them more susceptible to health impacts from exposure.[13]

Over the last 40 years, concentrations of priority air pollutants such as nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$) have declined substantially.[14] However, the UK still currently fails to meet statutory air quality objectives for NO_2 in many urban areas[15], and mean $PM_{2.5}$ concentrations across much of the UK exceed World Health Organisation (WHO) 2021 Global Air Quality Guidelines.[16] Transport remains an important source of air pollution, accounting for 34% of nitrogen oxide (NO_x) emissions and 13% of $PM_{2.5}$ emissions in 2018.[17] In urban environments, road traffic is often the dominant source of NO_x and NO_2 emissions[18,19], and is consequently a target for contemporary policy interventions.[20] Such intervention includes the introduction of 'Low Emission' or 'Clean Air Zones', mandated in multiple UK cities to achieve legislative compliance and improve air quality.

What is a Clean Air Zone?

A Clean Air Zone (CAZ) defines an area where targeted action is taken to improve air quality. According to the Clean Air Zone Framework, published in 2020 by the Department for Environment, Food & Rural Affairs (Defra) and the Department for Transport (DfT), a CAZ should bring together local measures to deliver immediate action to improve air quality and health, support local growth and ambition, and a transition to a low emission economy.[21]

There are two types of CAZ:

1. Charging CAZ – *where users of the most polluting vehicles are discouraged from entering the zone via imposing fees.*

In a charging CAZ, vehicles that do not meet minimum emissions standards (based upon its EURO standard) are required to pay a fee to enter or operate within the CAZ. For example, a diesel car must meet Euro 6 standards, and a petrol car must meet Euro 4 standards. There are four increasingly stringent classes of charging CAZ (class A to D) controlling which types of vehicles are required to meet the standards (see table below). A charging-CAZ is *synonymous* with a Low Emission Zone (LEZ), and throughout this briefing note we use both terms for consistence with Government guidance and reporting. Other charging measures such as the Ultra Low Emission Zone (ULEZ) or Zero Emission Zone (ZEZ) are also classed as a charging-CAZ but may adopt different emission standards.

A local authority may also choose to implement a 'non-charging CAZ'.

Class	Vehicle type
A	Buses, coaches, taxis, private hire vehicles
B	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles (HGVs)
C	Buses, coaches, taxis, private hire vehicles, HGVs, vans, minibuses
D	Buses, coaches, taxis, private hire vehicles, HGVs, vans, minibuses, cars, (the local authority has the option to include motorcycles)

"Clean Air Zones improve the urban environment to support public health and the local economy, making cities more attractive places to live, work, do business and spend leisure time. They support cities to grow and transition to a low emission economy thus ensuring these benefits are sustainable for the long term."

– Government's vision for Clean Air Zones

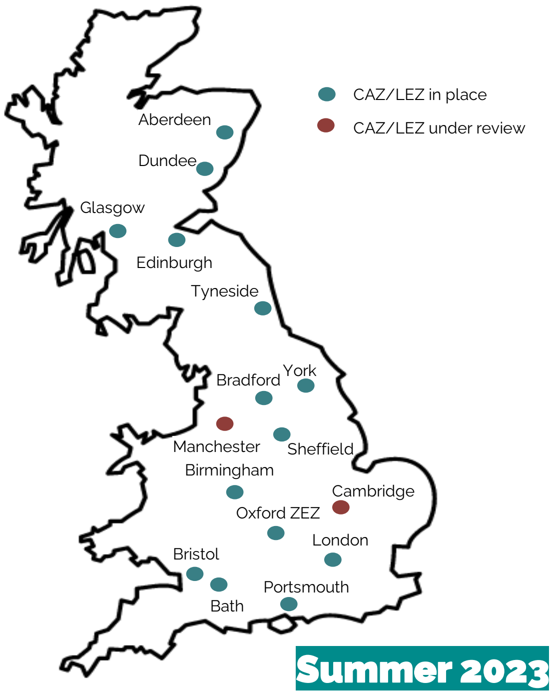
2. Non-charging CAZ – *which do not include the use of charge-based access restrictions, and rely on other measures to improve air quality.*

This may include broader transport measures such as optimising traffic management, and accelerating ultra-low emission vehicle take-up, or broader air quality management strategies including measures to minimise stove and wood burner emissions, or encourage the use of low-NO_x boilers.[21] For the purpose of this note, a CAZ refers specifically to a charging-CAZ.

CAZs were first announced in the UK Government's 2015 national plan to improve air quality, with five cites (Birmingham, Leeds, Nottingham, Southampton and Derby) mandated to plan and implement a CAZ by 2020.[22] This plan was later withdrawn and replaced by the 2017 UK Plan for tackling roadside nitrogen dioxide concentrations[23], where the government identified CAZs as the "fastest and most cost-effective way of meeting NO_2 limit values on the majority of urban roads". 36 local authorities were further directed to produce local plans to reduce NO_2 levels in the shortest time possible, and are required to benchmark proposals against the possible introduction of a charging CAZ. It should be noted that if a local authority can identify alternative measures that were at least as effective at reducing NO_2, those measures should be preferred. The Government provided extensive guidance for local authorities through the 2017 CAZ Framework (later updated in 2020[21]). However, the implementation of CAZs and selection of alternative measures has been inconsistent and faced multiple challenges including public concerns and impacts of the COVID-19 pandemic.

Where are the UK LEZ/CAZs?

To date (July 2023), in England CAZ/LEZs have been implemented in Bath, Birmingham, Bradford, Bristol, London (both the Greater London LEZ and the Central London ULEZ), Oxford (ZEZ), Portsmouth, Sheffield and Tyneside (Newcastle and Gateshead). A bus-only CAZ has also been Introduced In York city centre. The Scottish Government has committed to introducing LEZs In Scotland's four biggest cities, with Glasgow's LEZ operational and enforcement beginning for Aberdeen, Dundee and Edinburgh's in 2023/24.[24] Some cities had previously planned CAZs but no longer require them due to air quality improvements (e.g., Leeds, Leicester and Nottingham). Several local authorities have opted for alternative measures in preference to CAZ proposals. Cardiff Council proposed a package of measures including a bus retrofitting programme, taxi mitigation measures and an active travel package making it easier for people to walk and cycle in the city centre, which was accepted in place of a CAZ.[25] Greater Manchester Combined Authority has abandoned the original CAZ plan due to go live in 2022 after concerns about financial hardship and compliant vehicle availability, and are now working to deliver a new clean air plan.[26] Across Europe there are over 300 active LEZs, which is expected to Increase to 507 by 2025.[53]



*As of July 2023 when document was prepared

What is the impact of Covid-19?

Many CAZ plans due to start in 2020 were postponed due to Covid-19. During national lockdown, much of the UK observed initial air quality improvements, as a result of reductions in traffic and industrial activities.[27,28] Some local authorities considered these temporary improvements as grounds to delay, or even cancel previous CAZ plans, on the grounds they were no longer necessary. However research has shown these benefits were typically short-lived, and actual emissions changes were lower than originally reported after accounting for the effects of weather and longer term trends.[29,30] By summer 2022 traffic volume and air pollution returned to, or even exceeded pre-pandemic levels in many cities.[31] Research has also found complex changes in travel behaviour post-pandemic[32] that will also need to be considered to ensure urban air quality measures are being implemented in the most effective manner.

Do they work?

For air quality?

The primary aim of a CAZ Is to achieve compliance with legislative limit values for NO2 in the shortest possible timescale. Limited available evidence does suggest that area-based traffic management strategies (like a LEZ/CAZ) can improve urban air quality[33], however generally, evidence on their efficacy is mixed[51,52] Across Europe, evidence on their effectiveness for air quality and health is largely inconsistent.[34] Early evidence from the London LEZ found it did not reduce NO_2 and only slightly reduced $PM_{2.5}$ (<3%) levels[35] likely due to overall traffic increasing during the study period. Later evidence identified reduced NO_2 and NO_x concentrations, but no improvements for PM_{10}[36] and more recent evidence from the original Central London ULEZ found roadside NO_2 concentrations reduced by 44%.[37]

Case study: Birmingham CAZ

Early indications from the Birmingham Class D CAZ introduced in June 2021 (findings provided in a 6-month interim report) showed average NO_2 levels reduced by 13%.[39] In a more recent study, Liu and colleagues[50] determined the causal impact of the CAZ policy, correcting for the effects of weather and historic air quality trends. They find that during its first year, the CAZ led to significant but modest reductions of roadside NO_2 and NO_x within (up to 3.4% and 5.4%, respectively) and outside (up to 6.6% and 11.9%, respectively) the zone, demonstrating the short-term effectiveness of the CAZ. They identified no significant impacts on $PM_{2.5}$ (the most harmful pollutant for human health) confirming the need for more rigorous and combined mitigation policies that will be necessary to achieve cleaner air and realise health gains.[50,53,54] Furthermore, due to the small proportion of the city population residing in the CAZ area (~55,000 residents), the overall health benefits at a city level are marginal.

For health?

Current evidence suggests that LEZs can improve air-pollution related health outcomes,[40] with a recent systematic review identifying consistent positive effects on cardiovascular disease, although results for other health outcomes (such as respiratory diseases, birth outcomes, dementia and lung cancer) were less consistent.[40] However, other studies, for example, have found that while the London LEZ resulted in small improvements in air quality, it did not result in improvement of children's respiratory health.[36] Detecting changes in air pollution levels and population health related to a policy intervention is challenging, and assessing whether these changes are due to a specific measure such as a LEZ is complex.[52] Continued monitoring and further evaluation of future schemes using routine data systems and standardised mechanisms for capturing outcomes would enhance the evidence base.[40,52] These should measure include measures of public understanding and awareness of air pollution and behavioural changes (e.g., transport mode choice) related to the schemes.

Unintended consequences of CAZs

CAZs present a broader opportunity for local authorities to improve air quality and public health, however, may also impact local communities and businesses with potential unintended consequences associated with restrictive management. Those from poor and disadvantaged communities are more likely to own older, used cars[41] that are less likely to meet the stricter emission standards of a CAZ or LEZ. Therefore, these communities may be disproportionately impacted by the introduction of charging schemes. Reducing the mobility of vulnerable, car-dependant groups may also have significant social effects, by contributing to social exclusion.[42] Before the implementation of London's LEZ, a prospective health impact assessment identified several important potential consequences.[43] Community access to services provided via transportation, such as minibuses used by community groups, including ethnic, voluntary, youth and disabled groups, or community services such as Meals on Wheels, and St. Johns Ambulance, could be negatively impacted due to increased costs.[43] Small businesses that rely on vehicles affected by the LEZ may also be negatively impacted, with potential knock-on effects for employment.[43]

Case study: Bradford CAZ

Bradford is one example of a local authority which was mandated by the UK Government to introduce a CAZ, which came Into place in September 2022. Bradford is a large multi-ethnic city (population ~550,000) that faces high levels of socio-economic deprivation, with 40% of residents living in areas that rank among the most deprived in England.[44] In a recent qualitative study, residents of Bradford felt the CAZ would financially disadvantage communities already living in socio-economic and environmental poverty.[45] Further research found that while families recognise air pollution as an important issue and are generally supportive of the CAZ in Bradford, support is weaker within communities living In deprived areas - driven by a perceived lack of policy cohesion and concerns around financial impacts.[46] Such research highlights the need to consult and engage with vulnerable and seldom-heard communities, and develop tailored approaches to communicate proposed benefits, in order to create a greater sense of ownership that could lead to wider acceptance.[45,46]

Beyond the LEZ

LEZs may achieve benefits including air quality improvements, reduced carbon emissions, increased physical activity, enhanced neighbourhood appearance and community cohesion, especially when delivered at scale and combined with other air quality measures.[47] However, as policy schemes which seek to achieve legal objectives, they are unlikely to be enough to attain increasingly stringent air quality targets such as the WHO 2021 Global Air Quality Guidelines[16] or the new Environmental Targets (Fine Particulate Matter) (England) Regulations 2023.[48] They also focus on urban areas, and do not address challenges of air quality in small towns and rural areas; they could be considered as an intermediary step towards wider clean air ambitions for city regions. More holistic policy interventions such as broadening the definition of non-compliant vehicles, increased fees for non-compliant vehicles, an expansion of zone coverage, providing incentives for uptake of public transport or active travel alternatives may be necessary to realise further air quality and health gains.[50]

Furthermore, LEZ/CAZs are currently based on Euro classes that are expected to be redundant once sufficient fleet turnover has occurred. For instance, in July 2025 the new Euro 7 emission standards (set to feature stricter limits on exhaust emissions and, importantly, also on non-exhaust emissions from brakes and tyres) will come into force. The UK Government's ban on the sale of new petrol and diesel cars is also due by 2030. Such measures are expected deliver appreciable air quality benefits in the context of ongoing NO_2 reductions.[55] The largest health benefits are likely to come from schemes that integrate approaches to support both a reduction in use of private motorised vehicles and increase active travel and public transport use.[58]Importantly, there is also a need for national policies which extend beyond road traffic to maximise air quality (and climate) benefits – including those which reduce $PM_{2.5}$ concentrations[56]. These should address other important sources such as domestic wood burning and energy production.[57]

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