

Introduction of battery electric buses in Oxford: Impact on air quality and noise pollution



Air pollution contributes to an estimated 30,000 deaths per year in the UK, with lifelong health harms from before birth to old age.¹ Traffic noise contributes to over 1.6 million healthy life years lost annually in Europe.² Transport noise has been identified as detrimental to mental and physical health.³

Bus fleet electrification is a key national and local policy mechanism to reduce exhaust pollutant emissions and to achieve net-zero transport targets.⁴

What is the ZEBRA Scheme?

The Zero Emission Bus Regional Area (ZEBRA) funding scheme is a national initiative contributing to transport decarbonisation and enhanced bus quality and provision. The scheme has supported the deployment of over 4000 zero emission buses in England since 2021. Oxfordshire County Council secured £32.8m funding from the Department for Transport (DfT) and this was supplemented by £43.7m from commercial bus operators (Oxford Bus Company and Stagecoach) and £6m from Oxfordshire County Council.

This funding supported the introduction of 159 battery electric buses, across 34 routes in Oxford city centre. At full implementation, electric buses account for 69% of daily bus mileage within the city and 49% of daily bus flow.

Key points

- In Oxford, 159 battery electric buses were introduced to contribute to transport decarbonisation, improve air quality and enhance bus quality and provision.
- Citywide nitrogen dioxide levels fell by an average of 10% in 2024, with reductions of up to 24% in areas of high bus traffic.
- Introduction of electric buses has lowered peak traffic noise by up to 5.1 dB, comparable to moving three times further away from a road.
- Electrifying bus fleets can improve people's city experience, creating a cleaner, more pleasant streetscape.
- Bus passengers and drivers noted better ride quality, improved accessibility, and a sense of civic pride.

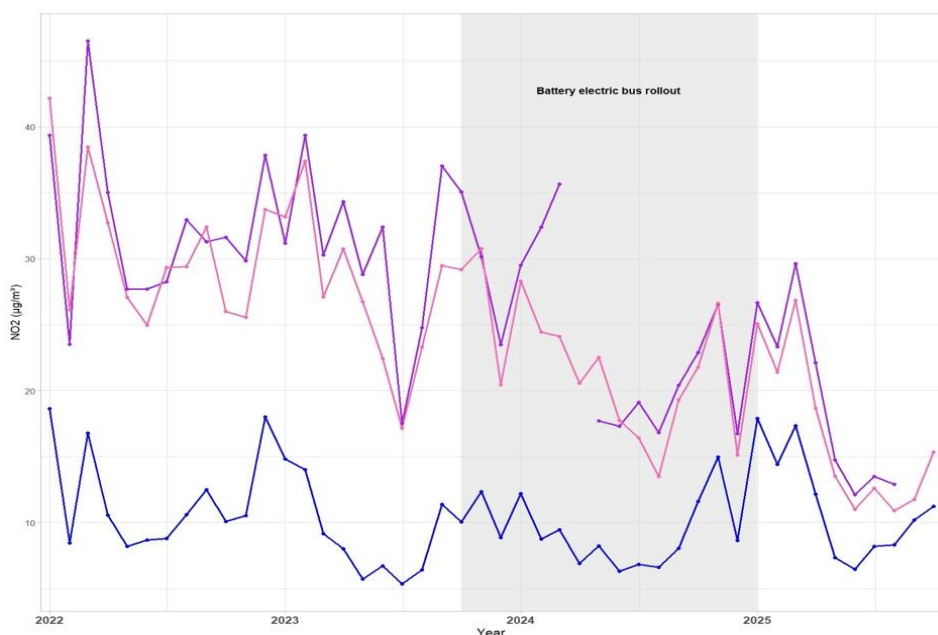
The scheme aimed to support local strategic objectives to reduce traffic congestion and improve air quality as part of the Oxford City Air Quality Action Plan (2021-25).⁵

Impact on air pollution

Provisional data analysis suggests that bus fleet electrification has **reduced roadside nitrogen dioxide (NO₂) concentrations**. Citywide annual average NO₂ levels fell by an average of 10% from 2023 to 2024, and up to 24% in areas of high bus traffic (St Aldates and High Street) (**Figure. 1**).⁶

Residents in Oxford told us that air quality improvements were noticeable from less exhaust smoke and diesel fumes.

They tend to just glide along the road rather than belching out lots of diesel smoke. (Resident/Commuter)



1 device used to measure noise

Figure 1 | Monthly average Nitrogen Dioxide (NO₂) concentration by reference monitoring station // Purple: Oxford Centre (St Aldates) – Roadside. Pink: Oxford High Street* – Roadside. Blue: Oxford St Ebbes – Urban Background. *Site managed by Oxford City Council. All data available at <https://www.oxonair.uk/data/>

Impact on noise pollution

The transition from diesel to electric buses in Oxford has had a **meaningful** and **measurable** impact on reducing traffic related noise in central areas, measured using Audiomoth devices (Figure 2).

The electric buses reduced roadside traffic related noise in central Oxford by an average of **5.1 decibels** (comparable to the reduction in noise you would experience by **moving 3 times further away from a road**) (Figure 3) with potential benefits for physical and mental health.

People told us that **reduced vehicle noise was a positive impact in the city centre**. Residents on bus routes reported fewer disturbances, including disruptions to sleep.

”

They stop nearly opposite my house, then you'd know straight away they're going past. But now we don't notice them half as much.
(Resident/Commuter)



The quieter buses led to some safety concerns for pedestrians and cyclists, particularly those who have hearing or sight impairment.

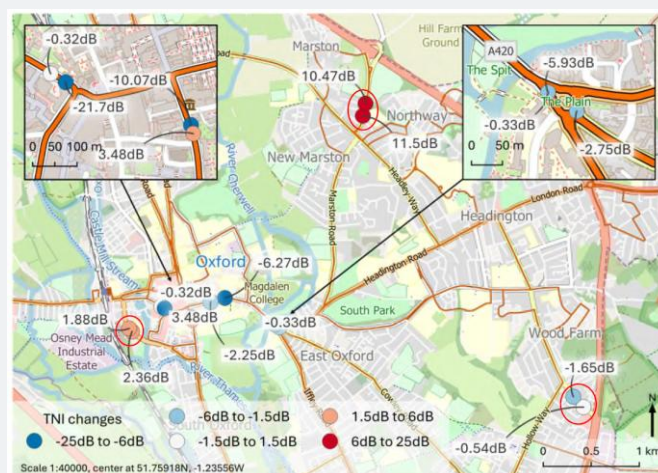


Figure 3 | Traffic noise index (TNI) changes by location (dB) with control locations circulated

Perceptions of the scheme

Bus fleet electrification **improves people's city experience**, creating a **cleaner, more pleasant streetscape**.

Bus passengers noted **better ride quality** and a sense of **civic pride** – feeling that their city cares for them. Although some benefits, including **improved accessibility** were due to an upgraded

bus fleet as opposed to the transition to electric vehicles.

Bus drivers had positive views on the new fleet, explaining that the experience of reduced vibrations and more responsive driving over long shifts **enhanced their wellbeing**.

”

As a driver, one major, major benefit when you sit in the cab for nine hours with an electric bus is you get out of it far less fatigued. (Bus driver)

Despite improved passenger experience, people said it had little impact on their bus use, with wider factors including cost, reliability and route connectivity impacting travel mode choice.



Monitoring and Evaluation – Recommendations

Here we propose recommendations for primary data collection to understand medium (3-6 month) to long-term (1-10 year) outcomes from the ZEBRA scheme

	Indicator(s)	Data source(s)	Data provider(s)
Health	Morbidity: disease incidence, hospital admissions, consultations, prescriptions Mortality: all-cause/cause-specific	Hospital Episode Statistics (HES) Primary care consultations Census data	NHS Digital Clinical Practice Research Datalink (CPRD) Office for National Statistics (ONS)
	Road casualties: killed/serious injuries	Casualty reports Road safety statistics	Local authority DfT
	Physical activity: pedestrian/cycle counts	Roadside sensors	Local authority
Environment	Occupational health: key groups (i.e. bus drivers, highway workers)	Bus and Coach driver statistics	Bus operators DfT
	Air and noise quality: NO ₂ , PM _{2.5} , PM ₁₀ , Ozone. Traffic noise index (dB)	Automatic monitoring, diffusion tubes Noise measurements	Defra Local authority Research institutions
	Carbon dioxide: whole-life cycle emissions	Energy consumption Recycling and disposal	Bus operators
	Meteorological: Temperature, humidity	Weather records	Met Office
	Traffic congestion	Traffic activity data	Local authority DfT
	Highway condition	Road surface quality	Local authority National Highways
Productivity	Retail sector activity	Footfall Expenditure Shop vacancies	Local authority Surveys
	Bus usage	ZEBRA quarterly data returns	DfT
Place-shaping	City streetscape	Focus groups, interviews	Local authority Research institutions
	Travel preferences	Focus groups, interviews	Local authority Research institutions
Connectivity and Inclusivity	Bus journey times	ZEBRA quarterly data returns	DfT
	Bus breakdowns/repairs	ZEBRA quarterly data returns	DfT
	Bus accessibility	Focus groups, interviews	Local authority Research institutions

Lessons learned from the scheme

Oxford's compact layout and dense urban bus network made it an ideal setting for rapid ZEBRA scheme rollout. Success depended on strong collaboration between bus operators and local authorities, underpinned by a shared vision for improved public transport services.

Local transport authorities, bus operators and suppliers should prioritise collective planning, co-operation and partnership to overcome practical and logistical challenges to scheme implementation. Timely installation of charging infrastructure, and provision of comprehensive staff training should be given equal importance to fleet procurement to enable effective scheme rollout within a defined period.

Public communications play a vital role in the public impact of ZEBRA schemes. Customising bus fleets with a consistent brand identity can raise awareness of scheme benefits. When designing messaging for vehicle livery and marketing materials it is important to consider a full range of sustainability factors, including energy sourcing and end-of-life recycling. These measures can strengthen public engagement, reinforcing the environmental credibility of sustainable transport initiatives.

Evaluation Methods

- Nitrogen Dioxide (NO₂) and Particulate Matter (PM_{2.5}, PM₁₀) were measured using Automatic Monitors and diffusion tubes (NO₂ only) in the Oxford City Area. Research analysis will use Interrupted Time Series design (1 Jan 2022 – 31 Oct 2025)
- Noise was measured using Audiomoth devices – low-cost recording devices mounted on street furniture at 16 locations around Oxford for one month before the intervention (Jan-Feb '24) and one month after the intervention (Jan-Feb '25) dates). Audiomoths were also mounted on board two electric and two diesel buses.
- We interviewed 10 key stakeholders with direct ZEBRA scheme involvement, including bus operators, elected council members and council officers. We conducted focus groups with 18 members from commercial bus operators, including drivers, engineers and operational staff.
- We conducted 1 focus group with 10 members of sustainable transport advocacy groups in Oxfordshire, 6 focus groups with 37 residents and commuters in Oxford and 47 brief 5-minute interviews on-board buses with bus users as they were using the electric buses.

The study protocol is available on <https://osf.io/ycpd6>. Ethical approval was provided by University of Birmingham Ethics Committee [ERN-3088].



Authors and acknowledgements

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We are grateful for the support of the study management team, which included Ruth Anderson, Melissa Goodacre, Dr Louisa Chenciner, Hannah Battye, Katie Parnell, Foyeke Tolani from Oxfordshire County Council, Pedro Abreu from Oxford City Council, Peter Richardson and Karen Keates as public collaborators and Dr Rosie Rowe from Ealing Council. We are also grateful to Dr Paul Mullins and Jason Taylor from Oxfordshire County Council for supporting evaluation data collection.

The Public Health Intervention Responsive Studies Team (PHIRST) PHRESH conceived the evaluation in collaboration with the local authority partner, all authors contributed to this process.

This study is funded by the National Institute for Health Research (NIHR) Public Health Intervention Responsive Studies Team (PHIRST/NIHR166658). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care

Citation

Garrott, K., Hodgson, J., Leach, F., Bartington, S., on behalf of the project team. 2025. Introduction of battery electric buses in Oxford. Impact on air quality and noise pollution. ZEBRA Evaluation Briefing Note No.1

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Metadata

<http://epapers.bham.ac.uk/id/eprint/4448/10.25500/epapers.bham.00004448>
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References

1. Royal College of Physicians. (2025). A breath of fresh air: responding to the health challenges of modern air pollution. Available at: <https://www.rcp.ac.uk/policy-and-campaigns/policy-documents/a-breath-of-fresh-air-responding-to-the-health-challenges-of-modern-air-pollution/> (Accessed: 10 November 2025)
2. World Health Organization. (2011). Burden of disease from environmental noise – quantification of healthy life years lost in Europe. Available at: <https://iris.who.int/server/api/core/bitstreams/4c6945b7-497a-4043-9e6f-98d6774b3b61/content> (Accessed: 27 October 2025)
3. Lan Y., Roberts H., Kwan M-P. and Helbich M. (2020) Transportation noise exposure and anxiety: A systematic review and meta-analysis, Environmental Research, 191, 110118, <https://doi.org/10.1016/j.envres.2020.110118>
4. Avenali A., Catalano G., Giagnorio M. and Matteucci G. (2024) Factors influencing the adoption of zero-emission buses: A review-based framework, Renewable and Sustainable Energy Reviews, 197, 114388, <https://doi.org/10.1016/j.rser.2024.114388>
5. Oxford City Council. (2021). Air quality action plan 2021. Available at: <https://www.oxford.gov.uk/downloads/file/805/air-quality-action-plan-2021-2025> (Accessed: 27 November 2025)
6. Oxford City Council. (2025). Air quality annual status report. Available at: <https://www.oxford.gov.uk/downloads/file/3692/air-quality-annual-status-report-2024> (Accessed: 14 November 2025)

Find the evaluation of the
ZEBRA scheme online:

