CBI Economics

Breathing life into Bristol

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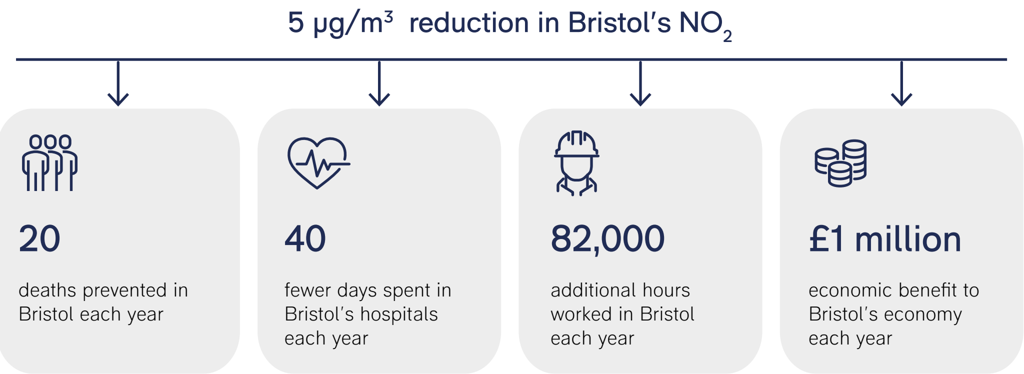
The economic benefits of reducing nitrogen dioxide levels in Bristol

Summary

CBI Economics analysis quantifies the potential gains to the health of Bristol's workforce, and to the local economy, that could be achieved through a reduction in nitrogen dioxide (NO_2) levels via the proposed Clean Air Zone (CAZ). Just a small reduction in NO_2 of 5 μ g/m^3 (18%) could prevent 20 deaths and save 40 days spent in Bristol's hospitals due to respiratory conditions each year.[1,2]

Moreover, adding 82,000 working hours each year through increased workforce participation could provide an economic boost of more than £1m in Gross Value Added (GVA).[3]

Figure 1 Economic and health benefits associated with reducing NO_2 in Bristol



Source: CBI Economics analysis

Air quality matters to the health of our citizens and ultimately to our economy

Air pollution impacts human health and the productivity of the UK workforce, which in turn impacts the economy. Analysis conducted by CBI Economics in 2020 estimated that clean air in line with the World Health Organisation's (WHO) guidelines could deliver a £1.6bn boost to the UK economy each year.[4]

Evidence shows a key link between NO_2 and health outcomes. Reducing NO_2 therefore has a key role to play in realising this economic potential. NO_2 exposure leads to both short-term and long-term health impacts, exacerbating respiratory conditions such as asthma, possibly increasing the likelihood of lung cancer, stroke, and cardiovascular disease, and has been linked to adverse birth outcomes.[5] This comes at a cost to the healthcare system. Public Health England estimates that between 2017 and 2025 the total cost to the NHS and social care system due to NO_2 alone will reach £61m.[6,7]

The role of Clean Air Zones

Vehicles are the largest contributor to NO_2 pollution at roadsides, contributing 80% of the total. This means higher levels of NO_2 are typically focused in high traffic areas within city centres. Targeted local action, in addition to a national strategy, is therefore a key part of the government's solution to tackling NO_2 levels in the UK.[8]

While the government has considered a range of policy options, the evidence concludes that CAZs are the most effective measure to reduce NO_2 levels within the legal limits in the shortest possible time.[9] As a result, the government has mandated several cities to implement CAZs, including Bristol.

Nitrogen dioxide levels in Bristol

The UK has statutory limit values for the annual and 1-hour mean concentrations of NO_2, set at 40 $\mu g/m^3$ and 200 $\mu g/m^3$ respectively.[10] Analysis by Ricardo Energy and Environment (Ricardo) finds that while on average NO_2 concentrations in Bristol comply with the annual limit value, the maximum annual concentration across locations in Bristol in 2019 exceeded this by 64% (26 $\mu g/m^3$). This exceedance is driven predominantly by six locations in the city centre (particularly on Colston Avenue, Anchor Road, York Road, and Bedminster Parade) and along the A38 on Bedminster Road, Jamaica Street, Ashley Road, Berkeley Road, and Cromwell Road[11], increasing to 15 locations when including those just below the limit value.[12]

Table 1 Statutory limit values and compliance assessment for NO_2 in Bristol, 2019

Pollution measure	UK statutory limit value	Average NO_2[13]	Maximum NO_2	Locations >40.4 μg/m³	Locations >36 μg/m³	Compliance assessment
NO_2 annual mean	40 μ g/m³	28 μ g/m³	66 μ g/m³	6	15	Non-compliant
NO_2 1-hour mean	200 μ g/m³	N/A	120 μ g/m³	N/A	N/A	Compliant

Source: Analysis by Ricardo

Bristol's proposed Clean Air Zone

Bristol is one of several UK cities tasked with reducing NO_2 concentrations, and part of their strategy is the introduction of a CAZ for Bristol's city centre by 29 October 2021 under the government's CAZ framework.[15,16]

The CAZ is based on Bristol's Air Quality Management Areas (AQMAs), which is a central area where approximately 100,000 people live, and more people work, study, or travel through.[17] Bristol City Council consulted on two options for the boundary of the CAZ[18], with their preferred option, a small CAZ D, covering a small area of central Bristol where older, more polluting commercial vehicles and private cars would pay to drive in the zone.[19]

Figure 2 Clean Air Zone boundary for Bristol[20]

■ CAZ Area

Source: CBI Economics analysis

Evidence from feasibility studies conducted across a range of cities suggests that introducing a CAZ D, thereby reducing the number of polluting vehicles entering the area, could reduce NO_2 concentrations by 5 μ g/m^3. This means Bristol would achieve compliance with national limits up to four years earlier than expected.[21,22]

CBI Economics analysis estimates that lower NO_2 levels could prevent at least 5% of Bristol's deaths associated with respiratory conditions each year

Bristol has a young and thriving population. Over two thirds (69%) of Bristol's population are of working age compared to an average of 62% in England and Wales.[23] Of these, almost 79% are currently in employment, and therefore improving the health of Bristol's workers could result in a significant gain to the local economy.[24]

Evidence shows the impacts of poor air quality fall disproportionately on the elderly, who are more likely to be outside the working population. In Bristol 89% of deaths associated with respiratory diseases fall within the over-65 age bracket.[25] The remaining 11% are therefore those of working age who are either unable to work due to medical reasons, or working with a respiratory medical condition (46% of working age Bristol residents with a non-circulatory or heart-related long-term health condition are either economically inactive or unemployed)[26,27]

In Bristol, 14% of all deaths and 5% of hospital admissions in 2019 were due to respiratory conditions.[28] A further 20% of deaths in 2019 were due to circulatory and heart conditions, and 6% due to malignant cancers, all of which are to an extent attributable to air pollution.[29] Reducing NO_2 levels could therefore prevent some premature deaths and reduce hospital admissions.

CBI Economics analysis finds that a 5 μ g/m^3 reduction in NO_2 in Bristol could, at a minimum, prevent between 10 to 21 deaths each year, and save 40 days spent in hospital due solely to NO_2 exposure.[30] This represents around 1% of all Bristol's deaths and 5% of deaths associated with respiratory conditions.[31]

The final health benefits of reducing NO_2 are likely to be far greater

As it was not possible to quantify all impact channels, the resulting health benefit is expected to go far beyond this.[32] The reasons for additional health benefits is due to the following:

- **A larger share of the UK's population will be exposed to cleaner air than just those living in Bristol's city centre:** Around one in five of those living in Bristol live within the CAZ boundary, but many of the remaining 80% of Bristol's population will travel through the CAZ for work, study or leisure, including over 58,000 students across the city who either live, shop, or socialise within the CAZ boundary.[33,34] Around 88,000 of Bristol's workers (40%) who live outside of Bristol commute into the city centre for work.[35] In addition, Bristol can see on average 15m visitors in a given year from outside of Bristol, 90% of which are UK day visitors.[36] A much larger group of the UK's population would therefore be exposed to cleaner air than the analysis is able to capture.[37]
- **Improving air quality will reduce a host of primary health conditions associated with air pollution:** The main conditions associated with air pollution are respiratory conditions, cardiovascular disease, and lung cancer, but there is emerging evidence of associations with low birth weight and Type 2 diabetes.[38,39] These conditions may be more closely linked with other pollutants, such as $PM_{2.5}$, but NO_2 exposure is likely to play a role within a wider mix of air pollutants. As this analysis is only focused on respiratory conditions, it underestimates the overall impact of lower NO_2 on all health outcomes related to air pollution.
- **Improving air quality will reduce health conditions where air pollution is a secondary factor:** Exposure to air pollution can also suppress lung function growth in children, and in adulthood it can accelerate the decline in lung function with age.[42] This increases the risk of death from other primary conditions. For example,, COVID-19 patients that already suffer from long-term respiratory conditions are at greater risk of death.[43] As a result, improvements in air quality will have knock-on impacts on other health outcomes in addition to those direct impacts captured by the analysis.
- **Reducing emissions from vehicles is expected to lead to a reduction in other pollutants:** Evidence suggests NO_2 is emitted with other pollutants, especially $PM_{2.5}$, which makes it difficult to determine NO_2 as the attributable pollutant to health outcomes.[44] In addition, road transport has been linked to other pollutants including $PM_{2.5}$, PM_{10} and ground level ozone, which means CAZs could lead to a reduction in other pollutants.[45] These reductions could therefore provide further health benefits not captured by this analysis. Since $PM_{2.5}$ is the largest determinant of health outcomes due to air pollution, this omission could be significant.[46,47]

CBI Economics analysis estimates that bringing NO_2 within legal limits will add £1m to Bristol's economy each year through increased workforce participation

Despite a disproportionate impact of air pollution on non-working residents, there is still expected to be a large impact on the working population. Analysis by CBI Economics shows that a healthier workforce in Bristol could result in an additional 38,000 to 82,000 hours worked.[48]

Assuming full employment, meaning that these extra hours can be put to immediate use, this could increase the total production in the economy by an additional £1m in GVA from preventing these health outcomes.

The final economic benefit to Bristol is likely to be much larger

The resulting economic benefit is expected to go beyond £1m GVA not only because the resulting health impacts are expected to be larger than it is possible to quantify, but also for the following reasons:

- **The resulting days lost from work in the event of a hospital admission will be higher than just the days in hospital:** Prior to a hospital admission, it is likely that an individual will already have been suffering and will also likely require time to recover, increasing the days lost from work over and above the time spent in hospital. However, this analysis only quantifies the impact of a reduction in NO_2 on the time spent in hospital due to availability of academic evidence.[49]
- **The value of unpaid work not carried out as a result of NO_2 cannot be estimated:** Activities taken outside of formal employment are estimated to be a significant contributor towards the UK economy: the ONS estimated unpaid work at 60% of GDP in 2016.[50] As a result, cost-benefit analyses on air pollution often seek to include this as an impact pathway for quantification.[51] However, it was not possible to quantify this as part of this analysis due to an absence of academic evidence solely for NO_2.

This analysis evidences the potential gains to Bristol's local economy and to the health of the work force by reducing NO_2 levels. With just a small 5 $\mu g/m^3$ reduction in NO_2 estimated to provide an additional £1m in GVA and prevent at least 20 deaths, it is evidence that lower NO_2 levels can be an engine for a healthier and more prosperous city.

References

1. This reduction in NO_2 is based on an estimate of the 2019 annual average NO_2 level for Bristol of 28 μ g/m³, estimated by Ricardo.
2. The number of deaths and hospitalisations will not stay the same as the years go on because of changes in population size and age structure as the deaths prevented accumulate over time. However, given this is a static analysis, the population and employment levels are assumed constant.
3. Real Gross Value Added (GVA) - Chained Volume Measures (2016 prices), i.e. accounting for the effect of inflation by using 2016 prices as the reference case. The figures refer to 2018. GVA is the value generated by any unit engaged in the production of goods and services. This includes the compensation of employees (wages and salaries, bonuses etc.), taxes (less subsidies) on production, and gross operating profits (including self-employment earnings) associated with the production a given level of output.
4. Breathing Life into the UK Economy, September 2020, CBI Economics commissioned by the Clean Air Fund.
5. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study
6. PHE (2018) Estimation of costs to the NHS and social care due to the health impacts of air pollution
7. However, caution should be used when interpreting these figures. Estimating NHS costs is complex, and the PHE study does not include the secondary impact of health care costs that arise from people living longer due to better air quality.
8. Defra (2017) UK plan for tackling roadside nitrogen dioxide concentrations.
9. DfT and Defra (2017) UK Plan for tackling roadside nitrogen dioxide concentrations: Technical report.
10. Statutory limit values are legally binding and must not be exceeded. In the case of NO_2 this is 40 μ g/m³ for the annual mean and 200 μ g/m³ for the 1-hour mean. In order for the UK to comply with the limit value, all local areas across the UK must be in compliance.
11. Bristol City Council (2019), 2019 Air Quality Annual Status Report, https://www.cleanairforbristol.org/wp-content/uploads/2019/09/Bristol_City_Council_2019_ASR_v1.pdf
12. UK best practice guidance, Local Air Quality Management Technical Guidance 2016 LAQM. TG(16) (Defra, 2018) states that the error of concentrations produced from air quality models should be within 10 % of the limit value. Therefore for NO_2 the error in modelled concentrations should be 4 μ g/m³, which means setting the limit value to 36 μ g/m³ takes into account error in the model.
13. The annual mean NO_2 concentrations are calculated by taking the average of the annual mean using monitoring data and the PCM roads model for roadside locations. While the hourly concentrations are measured by analysing the relationship between the annual mean and 1-hour maximum based on a regression equation.
14. The annual mean measures the average of the annual mean using all the roadside data, while the maximum figures is the maximum annual mean concentration.
15. Clean Air Zone Framework, Principles for Setting up Clean Air Zones in England, February 2020.
16. Bristol City Council, Decision Pathway -Report, Meeting 25 February 2021, Department for Environment, Food and Rural Affairs and Department for Transport.
17. https://www.cleanairforbristol.org/

18. https://www.cleanairforbristol.org/
19. https://www.cleanairforbristol.org/wp-content/uploads/2021/02/Small-CAZ-D.pdf
20. A Class D clean air zone is the most comprehensive in terms of the range of vehicles that fall within scope of the CAZ. This type of CAZ therefore applies to: buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses and cars. The local authority also has the option to include motorcycles within the CAZ D.
21. This is based on CAZ feasibility studies for Bath, Birmingham, Caerphilly, Cardiff, Derby, Liverpool, Manchester and Newcastle.
22. This is based on an average of the estimated reduction in NO_2 following the introduction of a CAZ-D across eight cities (Bath, Birmingham, Caerphilly, Cardiff, Derby, Liverpool, Manchester and Newcastle), sourced from each city's CAZ feasibility studies.
23. ONS (2021), Population Estimates, 2019
24. ONS (2021), Annual Population Survey – Employment rate, 2019
25. ONS (2021), Mortality Statistics by Underlying Cause and Age, 2019
26. ONS (2020) Mortality Statistics
27. ONS (2021), Annual Population Survey – Employment rate, 2019
28. ONS (2020) Mortality Statistics
29. Ibid.
30. The estimate for deaths is based on long-term exposure to NO_2 while the hospital admissions figures are due to short-term NO_2 exposure. A full explanation of the methodology can be found in the accompanying methodology document.
31. This is based on the upper end estimate of 21 deaths prevented, calculated using deaths data from the ONS.
32. Limited academic evidence on the quantification of a reduction in NO_2 on the health of a population meant that several channels of impact were not quantified. A full explanation of this can be found in the accompanying methodology document.
33. HESA (Higher Education Statistical Agency), 2021 – HE Student Data by HE Provider, 2019/20
34. Bristol City Council (2020), The Population of Bristol.
35. Estimates based on the 2011 Census of Population (origin-destination statistics) and ONS Population Estimates for 2019. The estimates are based on the difference between the number of all usual residents and Bristol residents who work in Bristol in 2011. This difference is subsequently projected forward to 2019 based on total population growth for Bristol between 2011 and 2019 (from the ONS Population Estimates).
36. Visit Britain (2020), Overnight and day visitors (from elsewhere in the UK and international) - 2019
37. The analysis is based on deaths and hospital admissions by local authority and therefore only captures those individuals recorded as living in Bristol or visiting Bristol's hospitals and not those from other local authorities.
38. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study
39. Li, Y (2019) Association between air pollution and type 2 diabetes: an updated review of the literature
40. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study
41. Li, Y (2019) Association between air pollution and type 2 diabetes: an updated review of the literature
42. Ibid.
43. Schultze et al (2020), "Risk of COVID-19-related death among patients with chronic obstructive pulmonary disease or asthma prescribed inhaled corticosteroids: an observational cohort study using the OpenSAFELY platform", Lancet Respiratory Medicine Journal, Vol. 8, Issue 11 (funded by UK Medical Research Council)

44. Air Quality Expert Group (2004) Nitrogen Dioxide in the United Kingdom Summary
45. DEFRA (2020) Air quality appraisal: impact pathways approach
46. Modelling the impact of CAZs on other pollutants such as $PM_{2.5}$ would have required a significant undertaking and a number of assumptions and therefore the decision was taken to omit this from the quantification.
47. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study.
48. The number of working years gained are converted into number of working days on the basis of the number of hours worked in a given week by all Bristol residents in employment (based on the ONS Annual Survey of Hours and Earnings 2019 data on average number of hours worked per week), and an assumed 48 weeks per year worked (4 weeks entitled to paid holiday).
49. The concentration response function (CRF) used in this analysis estimates the impact of a unit change in concentration to the number of hospital admissions due to respiratory disease. It does not capture the full extent of working days lost due to respiratory illness. To do this we would need figures on sickness absence in the workforce due to respiratory illness, to capture days lost sick at home and in hospital.
50. ONS (2016) Household Satellite Account.
51. Defra (2012), Valuing the Impacts of Air Quality on Productivity.

This report was produced by CBI Economics and commissioned by the Clean Air Fund using modelling by CBI Economics based on input data from a variety of sources.

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