



Breathing life into Liverpool

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The economic benefits of reducing nitrogen dioxide in Liverpool

Summary

CBI Economics analysis quantifies the potential gains to the health of Liverpool's workforce and to the local economy, that could be achieved through a reduction in nitrogen dioxide (NO₂) levels via the proposed Clean Air Zone (CAZ). Just a small reduction in NO₂ of 5µg/m³ (17%) could prevent 30 deaths and save 70 days spent in Liverpool's hospitals due to respiratory conditions each year.^{1,2}

Moreover, adding 113,000 working hours each year through increased workforce participation could provide an economic boost of more than £1.5m in Gross Value Added (GVA).³

Figure 1 Economic and health benefits associated with reducing NO₂ in Liverpool



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 NO₂ and health outcomes. Reducing NO₂ therefore has a key role to play in realising this economic potential. NO₂ 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 NO₂ alone will reach £61m.^{6,7}

The role of Clean Air Zones

Vehicles are the largest contributor to NO₂ pollution at roadsides, contributing 80% of the total. This means higher levels of NO₂ 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 NO₂ 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 NO₂ levels within the legal limits in the shortest possible time.⁹ As a result, the government has mandated several cities to implement CAZs, including Liverpool.

Nitrogen dioxide levels in Liverpool

The UK has statutory limit values for the annual and 1-hour mean concentrations of NO₂, set at 40 µg/m³ and 200 µg/m³ respectively.¹⁰ Analysis by Ricardo Energy and Environment (Ricardo) finds that while average NO₂ concentrations in Liverpool comply with the annual limit value, the maximum annual concentration across locations in Liverpool in 2019 exceeded this by more than 20% (9 µg/m³). This exceedance is driven predominantly by five locations, increasing to 21 locations when including those just below the limit value.¹¹ In 2019 Liverpool City Council declared a 'climate change emergency' and has since begun work on a clean air plan to improve air quality in the city. As part of this, Liverpool has drafted plans to redesign the Strand and Lime Street to reduce congestion and air pollution.

Table 1 Statutory limit values and compliance assessment for NO₂ in Liverpool, 2019

Pollution measure	UK statutory limit value	Average NO ₂ ¹²	Maximum NO ₂ ¹³	Locations >40.4 µg/m ³	Locations >36 µg/m ³	Compliance assessment
NO ₂ annual mean	40 µg/m ³	29 µg/m ³	49 µg/m ³	5	21	Non-compliant
NO ₂ 1-hour mean	200 µg/m ³	N/A	122 µg/m ³	N/A	N/A	Compliant

Source: Analysis by Ricardo

A Clean Air Zone for Liverpool

Liverpool has been mandated by the government to reduce its NO₂ concentrations in line with the limit values, in the shortest possible time. To address this, in 2019, Liverpool City Council submitted a business case for a potential CAZ.¹⁴ However, Liverpool is less advanced in its development of a CAZ compared to other cities, with some cities such as London already implementing the policy, while others have carried out public consultations. In contrast, Liverpool City Council is still in the process of determining the size and location of a potential CAZ and is due to confirm these details later this year.



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 NO₂ concentrations by 5 µg/m³. This means Liverpool would achieve compliance with national limits up to four years earlier than expected.^{16,17}

CBI Economics analysis estimates that lower NO₂ levels could prevent at least 3% of Liverpool's deaths associated with respiratory conditions each year

Liverpool has a young and vibrant population. The median age in the city is 35, more than five years younger than the UK average and almost 68% of Liverpool's population are of working age compared to an average of 62% in England and Wales.¹⁸ Of these, 68% are currently in employment, and therefore improving the physical wellbeing of Liverpool's workers could result in a significant gain to the local economy.¹⁹

Evidence shows the impacts of poor air quality fall disproportionately on the elderly, who are more likely to be outside the working population. In Liverpool 85% of deaths associated with respiratory diseases fall within the over-65 age bracket.²⁰ The remaining 15% of deaths are among working-age residents with long-term conditions, 56% of which are economically inactive or unemployed.²¹

In Liverpool, 16% of all deaths in 2019 were due to respiratory conditions as the underlying cause, and 7% of hospital admissions.²² A further 22% of deaths in 2019 were due to circulatory and heart conditions, and 8% due to malignant cancers, all of which are to an extent attributable to air pollution.²³ Reducing NO₂ levels could therefore prevent premature deaths and reduce hospital admissions associated with exposure to NO₂.

CBI Economics analysis finds that a 5 µg/m³ reduction in NO₂ in Liverpool could, at a minimum, prevent between 13 to 28 deaths each year, and save 70 days spent in hospital due solely to NO₂ exposure.²⁴ This represents around 1% of all Liverpool's deaths and 4% of deaths associated with respiratory conditions.²⁵

The final health benefits of reducing NO₂ 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.²⁶ 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 Liverpool:** Many of the city's residents work within Liverpool, however, this analysis does not capture those individuals who enter the area for work, study, or leisure. Around 98,000 (44%) of workers who live outside of Liverpool commute into the area for work.²⁷ In addition, the city can see on average 16m visitors each year from outside of Liverpool, 90% of which are UK day visitors.²⁸ A much larger group of the UK's population would therefore be exposed to cleaner air than the analysis is able to capture.²⁹
- **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.^{30,31} These conditions may be more closely linked with other pollutants, such as PM_{2.5}, but NO₂ 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 NO₂ 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.³² 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.³³ 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 NO₂ is emitted with other pollutants, especially PM_{2.5}, which makes it difficult to determine NO₂ as the attributable pollutant to health outcomes.³⁴ In addition, road transport has been linked to other pollutants including PM_{2.5}, PM₁₀ and ground level ozone, which means CAZs could lead to a reduction in other pollutants.³⁵ 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.^{36,37}

CBI Economics analysis estimates that bringing NO₂ within legal limits will add £1.5m to Liverpool'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 could result in an additional 53,000 to 113,000 hours worked.³⁸

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 £1.5m in GVA from preventing these health outcomes.³⁹

The final economic benefits are likely to be much larger

The resulting economic benefit is expected to go beyond £1.5m GVA both because the resulting health impacts are expected to be larger, but also because of the following reasons:

- **The resulting days lost from work in the event of a hospital admission will be higher than just the days spent in hospital:** An individual will likely have been suffering prior to a hospital admission and will also likely require time to recover, increasing the days lost from work above just the time spent in hospital. However, this analysis only quantifies the impact of a reduction in NO₂ on the time spent in hospital due to availability of academic evidence.⁴⁰
- **The value of unpaid work not carried out as a result of conditions related to NO₂ emissions 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 2016.⁴¹ For example, activities such as volunteering and unpaid social care also add value to the local economy but are not captured in this analysis. As a result, cost benefit analyses on air pollution often seek to include this as an impact pathway for quantification.⁴² However, it was not possible to quantify this as part of this analysis due to an absence of academic evidence solely for NO₂.

The benefits of addressing Liverpool's NO₂ concentrations is evident, with this analysis demonstrating the potential gains to Liverpool's local economy and to the health of the work force by reducing NO₂ levels. With just a small 5 µg/m³ reduction in NO₂ estimated to provide an additional £1.5m in GVA and prevent 30 deaths, it is clear that lower NO₂ levels can be an engine for a healthier and more prosperous city.

References

1. The reduction in NO₂ concentrations is based on an estimate of the 2019 annual average NO₂ level for Liverpool of 29 µg/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 NO₂ this is 40 µg/m³ for the annual mean and 200 µg/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. 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 NO₂ the error in modelled concentrations should be 4 µg/m³, which means setting the limit value to 36 µg/m³ takes into account error in the model.
12. The annual mean NO₂ 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.
13. 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.
14. Liverpool City Council (2019) Strategic Outline Case.
15. 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.
16. This is based on CAZ feasibility studies for Bath, Birmingham, Caerphilly, Cardiff, Derby, Liverpool, Manchester and Newcastle.
17. This is based on an average of the estimated reduction in NO₂ 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.
18. ONS (2021), Population Estimates, 2019

19. ONS (2021), Annual Population Survey – Employment rate, 2019
20. ONS (2021), Mortality Statistics by Underlying Cause and Age, 2019
21. ONS (2020) Mortality Statistics; ONS (2021), Annual Population Survey – Employment rate, 2019
22. ONS (2020) Mortality Statistics
23. Ibid.
24. The estimate for deaths is based on long-term exposure to NO₂ while the hospital admissions figures are due to short-term NO₂ exposure. A full explanation of the methodology can be found in the accompanying methodology document.
25. This is based on the upper end estimate of 21 deaths prevented, calculated using deaths data from the ONS.
26. Limited academic evidence on the quantification of a reduction in NO₂ 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.
27. 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 Liverpool residents who work in Liverpool in 2011. This difference is subsequently projected forward to 2019 based on total population growth for Liverpool between 2011 and 2019 (from the ONS Population Estimates).
28. Visit Britain (2020), Overnight and day visitors (from elsewhere in the UK and international) - 2019
29. The analysis is based on deaths and hospital admissions by local authority and therefore only captures those individuals recorded as living in Liverpool or visiting Liverpool's hospitals and not those from other local authorities.
30. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study
31. Li, Y (2019) Association between air pollution and type 2 diabetes: an updated review of the literature
32. Ibid.
33. 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)
34. Air Quality Expert Group (2004) Nitrogen Dioxide in the United Kingdom Summary
35. DEFRA (2020) Air quality appraisal: impact pathways approach
36. 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.
37. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study
38. 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 Liverpool 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).
39. 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.
40. 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.
41. ONS (2016) Household Satellite Account.
42. Defra (2012), Valuing the Impacts of Air Quality on Productivity.

CBI Economics

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.

Want to find out more about this report or CBI Economics services? Then please contact:

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