CBI Economics

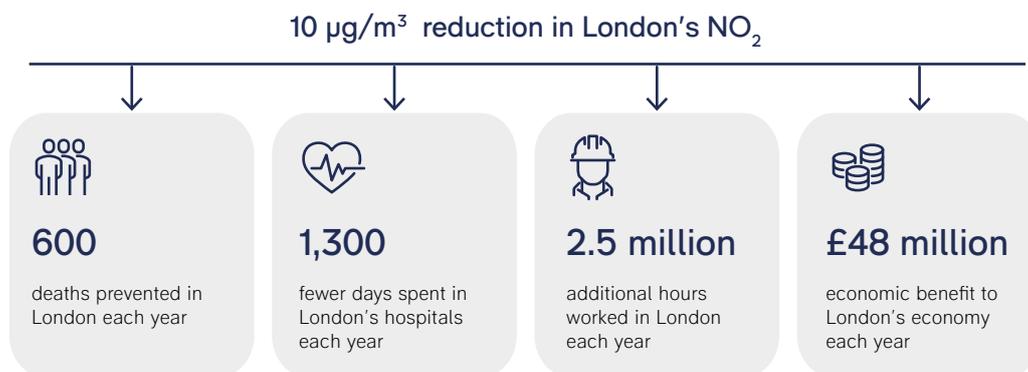# Breathing life into London

April 2021

The economic benefits of reducing nitrogen dioxide in London

Summary

CBI Economics analysis quantifies the potential gains to the health of London's workforce, and to the local economy, that could be achieved through a reduction in nitrogen dioxide (NO_2) levels via the proposed extension of London's existing Ultra Low Emission Zone (ULEZ). Just a small reduction in NO_2 of 10 µ g/m^3 (28%)[2] could prevent over 600 deaths and save over 1,300 days spent in London's hospitals due to respiratory conditions each year.[2]

Moreover, adding 2.5m working hours each year through increased workforce participation could provide an economic boost of more than £48m in Gross Value Added (GVA).[3]

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

10 µg/m^3 reduction in London's NO_2

600
deaths prevented in London each year

1,300
fewer days spent in London's hospitals each year

2.5 million
additional hours worked in London each year

£48 million
economic benefit to London's economy each year

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 Clean Air Zones (CAZ) 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 London.

Nitrogen dioxide levels in London

The UK has statutory limit values for the annual and 1-hour mean concentrations of NO_2, set at 40 μg/m^3 and 200 μg/m^3 respectively.[10] Analysis by Ricardo Energy and Environment (Ricardo) finds that while average NO_2 concentrations in London comply with the annual limit value, the maximum annual concentration across locations in London in 2019 exceeded this by 95% (38 μg/m^3). This exceedance is driven predominantly by 422 locations, increasing to 659 locations when including those just below the limit value.[11]

Table 1 Statutory limit values and compliance assessment for NO_2 in London, excluding the current ULEZ area, 2019

Pollution measure	UK statutory limit value	Average NO_2[12]	Maximum NO_2[13]	Locations >40.4 µg/m³	Locations >36 µg/m³	Compliance assessment
NO_2 annual mean	40 µg/m³	36 µg/m³	78 µg/m³	422	659	Non-compliant
NO_2 1-hour mean	200 µg/m³	N/A	147 µg/m³	N/A	N/A	Compliant

Source: Analysis by Ricardo

Extending London's ULEZ beyond Central London

London became the first city in the world to introduce a Clean Air Zone in April 2019.[14] The ULEZ was designed to reduce NO_2 concentrations by restricting the use of polluting vehicles in Central London. While the ULEZ has had a clear impact on air pollution, contributing to a 44% reduction in NO_2 levels within the boundaries of the ULEZ[15], NO_2 levels in London remain above the legal limit values. To address this, on 25 October 2021, the ULEZ will be expanded beyond central London up to the North and South Circular Roads.[16]

The planned extension will include several new boroughs, such as Kensington and Chelsea, Tower Hamlets, and Haringey, thus dramatically increasing the number of residents and visitors that will benefit from the policy. **Figure 2** illustrates the change to the city's CAZ boundary, extending the current ULEZ to the wider area to be introduced in October 2021.

Figure 2 London including the boundary of an extended ULEZ[17]

■ Current ULEZ area
■ Extended ULEZ area

Source: CBI Economics analysis

Since the introduction of the ULEZ, the average reduction in NO_2 is estimated to be 20 μ g/m³ and the ULEZ expansion report estimates that the new ULEZ area will lead to an additional reduction in NO_2 of between 5 μ g/m³ and 15 μ g/m³.[18] Drawing on this evidence, this analysis assumes an average NO_2 reduction of 10 μ g/m³ to understand the potential economic benefits associated with the ULEZ expansion. [19]

CBI Economics analysis estimates that lower NO_2 levels could prevent at least 10% of London's deaths associated with respiratory conditions each year

London is home to 13% of the UK population and a dynamic labour market. Over two thirds (67%) of London's population are of working age compared to an average of 62% in England and Wales.[20] Of these, almost 77% are currently in employment, and therefore improving the health of London's workers could result in a significant gain to the local economy.[21]

Evidence shows the impacts of poor air quality fall disproportionately on the elderly, who are more likely to be outside the working population. In London 90% of deaths associated with respiratory diseases fall within the over 65s.[22] The remaining 10% are therefore those of working age who are either unable to work due to medical reasons, or are working with a respiratory medical condition (49% of working age London residents with a non-circulatory or heart-related long-term health condition are either economically inactive or unemployed).[23,24]

In London, 13% of all deaths in 2019 were due to respiratory conditions, and 6% of hospital admissions.[25] A further 26% of deaths in 2019 were due to circulatory and heart conditions, and 6% due to malignant cancers, all of which are also to an extent attributable to air pollution.[26] Reducing NO_2 levels could therefore prevent some premature deaths and reduce hospital admissions.

CBI Economics analysis finds that a 10 μ g/m³ reduction in NO_2 in London's extended ULEZ area could, at a minimum, prevent between 286 and 614 deaths each year, and save over 1,300 days spent in hospital due solely to NO_2 exposure.[27] This represents around 1% of all London's deaths and 10% of deaths associated with respiratory conditions.[28]

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.[29] The reasons for additional health benefits are due to the following:

· **A larger share of the UK's population will be exposed to cleaner air than just those living in London's expanded ULEZ:** While millions of people live within the ULEZ extension, many more will travel through the area for work, study, or leisure. For example, there are over 426,000 students across the London region, many of which live, shop, or socialise within the ULEZ boundary.[30] An estimated 870,000 of workers in the London region (21%) commute into the region for work from outside the region.[31] As a central tourist attraction, the London region can see on average 293m visitors in a given year, 96% of which are UK day visitors.[32] A much larger group of the UK's population would therefore be exposed to cleaner air than the analysis is able to capture.[33]

· **A greater reduction in NO_2 could be realised after the ULEZ extension than assumed in this analysis:** The size of the NO_2 reduction estimated in Transport for London's feasibility study has an upper bound of 15 µ g/m³, which is 5 µ g/m³ higher than the reduction assumed in CBI Economics' analysis. To ensure a robust approach, the average value of 10 µ g/m³ was applied to the analysis of London.[34] However, applying the larger reduction to London would result in larger reductions in hospitalisations and deaths than has been accounted for in this analysis.

· **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.[35,36] 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.[37] 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.[38] 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 likely 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.[39] 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.[40] 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.[41,42]

CBI Economics analysis estimates that bringing NO$_2$ within legal limits will add £48m to London'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 London could result in an additional 1.2m to 2.5m hours worked.[43]

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 £48m in GVA from preventing these health outcomes.

The final economic benefit to London is likely to be much larger
The resulting economic benefit is expected to go beyond £48m 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, an individual will likely have been suffering already 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 NO$_2$ on the time spent in hospital due to availability of academic evidence.[44]

- **The value of unpaid work not carried out as a result of conditions related to NO$_2$ 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.[45] 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.[46] However, it was not possible to quantify this as part of this analysis due to an absence of academic evidence solely for NO$_2$.

The extension of the ULEZ in London therefore can go some way in delivering vast benefits to the city and its diverse work force. This analysis evidences the potential gains to London's local economy and to the health of the workforce through a reduction in NO$_2$ levels. With just a small 10 μg/m^3 reduction in NO$_2$ estimated to provide an additional £48m in GVA and prevent over 600 deaths at a minimum, it is clear that lower NO$_2$ levels can be an engine for a healthier and more prosperous city.

References

1. This change is based on an estimate of the 2019 annual average NO_2 level for London of 36 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. 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.

12. 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.

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. Greater London Authority (2020) central London Ultra low Emission Zone: Ten Month Report

15. Greater London Authority (2020) central London Ultra low Emission Zone: Ten Month Report

16. Transport for London (2021) ULEZ expansion

17. 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.

18. See accompanying methodology document.

19. See accompanying methodology document.

20. ONS (2021), Population Estimates, 2019

21. ONS (2021), Annual Population Survey – Employment rate, 2019

22. ONS (2021), Mortality Statistics by Underlying Cause and Age, 2019

23. ONS (2020) Mortality Statistics

24. ONS (2021), Annual Population Survey – Employment rate, 2019

25. ONS (2020) Mortality Statistics

26. Ibid.

27. 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.

28. This is based on the upper end estimate of 21 deaths prevented, calculated using deaths data from the ONS.

29. 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.

30. HESA (Higher Education Statistical Agency), 2021 – HE Student Data by HE Provider, 2019/20

31. 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 London residents who work in London in 2011. This difference is subsequently projected forward to 2019 based on total population growth for London between 2011 and 2019 (from the ONS Population Estimates).

32. Visit Britain (2020), Overnight and day visitors (from elsewhere in the UK and international) - 2019

33. The analysis is based on deaths and hospital admissions by local authority and therefore only captures those individuals recorded as living in London or visiting London's hospitals and not those from other local authorities.

34. Analysis provided by Ricardo shows that the impact of a CAZ D will vary by city. The larger the area of the clean air zone, the greater number of vehicles in scope, and therefore the greater the estimated NO_2 reduction. Other factors also include how far a city is away from the statutory limit values, in which case the level of change could be greater.

35. Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study

36. Li, Y (2019) Association between air pollution and type 2 diabetes: an updated review of the literature

37.   Ibid.

38. 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)

39. Air Quality Expert Group (2004) Nitrogen Dioxide in the United Kingdom Summary

40. DEFRA (2020) Air quality appraisal: impact pathways approach

41. 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.

42.   Bengtson, M (2020) The effect of nitrogen dioxide on low birth weight in women with inflammatory bowel disease: a Norwegian pregnancy cohort study.

43. 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 London 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).

44. 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.

45. ONS (2016) Household Satellite Account.

46. Defra (2012), Valuing the Impacts of Air Quality on Productivity.

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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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