

**CLEAN  
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# THE CLEAN AIR DIVIDEND OF NET ZERO:

**Air quality, health, and economic  
co-benefits from UK decarbonisation pathways**



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## Glossary and abbreviations

### **AQ (Air Quality)**

The condition of the air in relation to the presence of pollutants that may affect human health, ecosystems and the environment.

### **BC (Black Carbon)**

A component of fine particulate matter produced through incomplete combustion of fossil fuels, biomass and other fuels. Black carbon contributes to both air pollution and climate warming.

### **CCC (Climate Change Committee)**

The UK's independent statutory body that advises the government on emissions targets and reports to Parliament on progress towards reducing greenhouse gas emissions and adapting to climate change.

### **COMEAP (Committee on the Medical Effects of Air Pollutants)**

An independent expert advisory committee that provides advice to the UK government on the health effects of air pollution.

### **CRF (Concentration-Response Function)**

A statistical relationship used to estimate how changes in pollutant exposure affect the risk or incidence of specific health outcomes.

### **GVA (Gross Value Added)**

A measure of economic output that represents the value generated by businesses, industries or sectors, net of intermediate consumption.

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### **Net zero**

A target to reduce greenhouse gas emissions as far as possible and balance any remaining emissions with removals, so that overall emissions added to the atmosphere are zero. In the UK, the government has committed to reaching net zero greenhouse gas emissions by 2050.

### **NO<sub>2</sub> (Nitrogen Dioxide)**

A harmful air pollutant primarily produced by combustion processes, particularly road transport, power generation and industrial activities. Long-term exposure is associated with respiratory and cardiovascular health impacts. NO<sub>2</sub> is one of a group of nitrogen oxides, collectively referred to as NO<sub>x</sub>, which are emitted from combustion sources and can contribute to NO<sub>2</sub> concentrations in the air.

### **PM<sub>2.5</sub> (Fine Particulate Matter)**

Airborne particles with a diameter of 2.5 micrometres or less. These particles can penetrate deep into the lungs and bloodstream and are associated with a wide range of adverse health outcomes.

### **VOLY (Value of a Life Year)**

A monetary estimate of the value society places on an additional year of life. Used in economic appraisal to value changes in mortality risk and life expectancy.



# Executive summary

## The clean air dividend of net zero

Air pollution remains one of the UK's most significant environmental health risks, contributing to premature mortality, chronic illness and wider economic costs through reduced productivity, pressure on healthcare systems and poorer quality of life. The UK's transition to net zero will fundamentally reshape the major sources of those emissions, across transport, buildings, industry and power generation. But the full value of that transition is not always fully reflected in the analysis that informs policy and investment decisions.

This study, commissioned by the Clean Air Fund and produced by CBI Economics and WSP, sets out to change that. It quantifies the air quality co-benefits of decarbonisation pathways aligned with the CCC Balanced Pathway, examining how falling emissions reduce population exposure to harmful pollutants and translating those improvements into measurable health and economic outcomes.

The findings make a compelling case. Climate and clean air policy in most cases are mutually reinforcing, that is, the same measures that cut greenhouse gas emissions also reduce exposure to nitrogen dioxide (NO<sub>2</sub>) and fine particulate matter (PM<sub>2.5</sub>), generating substantial and long-lasting gains for public health, workforce productivity and local communities.

Moreover, cleaner air is not a secondary benefit of net zero delivery. It is one of its most significant and immediate dividends. Importantly, many of these benefits are realised well before the UK reaches net zero. Achieving the Balanced Pathway in the four key sectors assessed in this study is associated with productivity gains reaching £153 million by 2030 and £2.4 billion by 2040, demonstrating that cleaner air delivers returns within today's policy and investment horizons rather than only in the distant future.

The study traces the pathway from decarbonisation to cleaner air, better health and economic value. It focuses on pollutants and health outcomes where the evidence base is strongest, providing a clear estimate of the measurable benefits associated with cleaner air.

The results should therefore be read as a lower-bound estimate of the clean air dividend. Wider impacts – including broader healthcare costs, black carbon-specific effects, educational outcomes, ecosystem benefits, cognitive impacts and some productivity channels – are not fully captured in the central valuation, meaning the full value of cleaner air is likely to be greater than the headline results alone.

The study models four illustrative scenarios aligned with the CCC's Balanced Pathway to net zero, focusing on sectors expected to deliver the largest air quality improvements:

- **Surface transport:** uptake of electric cars, vans and HGVs, alongside modal shift and vehicle efficiency improvements;
- **Buildings (residential and non-residential combustion):** heat decarbonisation in homes and commercial buildings through electrification, heat pumps and efficiency improvements;
- **Industrial combustion:** decarbonisation of industrial fuel use through electrification, hydrogen, carbon capture and cleaner electricity supply; and
- **Combined pathway:** implementation of all three sector pathways, alongside power generation decarbonisation.

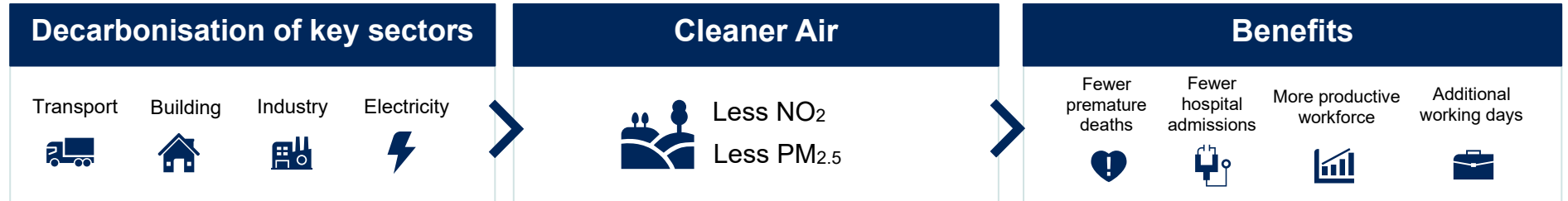
Each sector scenario includes the same decarbonised power generation pathway, reflecting the enabling role of cleaner electricity across the wider transition.

WSP modelled annual changes in NO<sub>2</sub> and PM<sub>2.5</sub> concentrations at 1 km × 1 km resolution across the UK under each pathway. These changes were population-weighted to estimate the average level of exposure to air pollution by giving more weight to areas where more people live, rather than taking a simple geographic average.




CBI Economics then translated these exposure reductions into health impacts using established concentration-response functions. The core economic result focuses on productivity gains from a healthier workforce, with supplementary analysis used to illustrate wider potential benefits, including avoided hospital admission costs and welfare values based on Green Book and Defra impact pathway approaches.

The analysis focuses particularly on NO<sub>2</sub> and PM<sub>2.5</sub> and is designed as an impact-pathway assessment rather than a full macroeconomic model. It therefore does not capture wider behavioural or general equilibrium effects. Some impacts also remain outside the quantified core valuation, including wider pollutant pathways, educational outcomes and ecosystem effects. The results should therefore be read as a focused estimate of measurable benefits, rather than a complete assessment of every channel through which cleaner air can generate value.

## VALUATION PATHWAY



## HEALTH IMPACTS

<p><b>~264,000</b> </p> <p>premature deaths avoided by 2050 rising to <b>335,000+</b> by 2070 once lagged effects are accounted for</p>	<p><b>~2.8 million</b> </p> <p>life years gained by 2050 ≈ More than <b>1 billion</b> additional days of life across the UK</p>	<p><b>~496,000</b> </p> <p>hospital admissions avoided by 2050 respiratory and cardiovascular — easing NHS pressure</p>
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## ECONOMIC VALUE

<p><b>£7.7 billion</b> </p> <p>additional GVA by 2050 from improved workforce health and reduced illness-related absence by 2050</p>	<p><b>&gt; £7 billion</b> </p> <p>Annual social welfare value by 2050 wider welfare value from improved health and longer lives (Defra / Green Book)</p>	<p><b>38 million</b> </p> <p>additional working days by 2050 ≈ <b>168,000</b> full-time working years returned to the economy</p>
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## What the findings tell us

Three broader messages emerge from the analysis.

### **Surface transport pathways generate the largest overall gains in the analysis, driven primarily by the scale of NO<sub>2</sub> reductions that follow from electrifying road transport.**

Combustion-related sectors are equally important for a different reason. Buildings and industrial decarbonisation deliver some of the largest declines in PM<sub>2.5</sub> exposure, reinforcing the case for treating heat and industrial policy as central to the clean air agenda rather than peripheral to it. The two pollutants tell complementary stories, and the full benefit of net zero depends on progress across both.

**The geographic picture is just as important as the sectoral one.** National averages mask substantial variation in who gains and by how much, with the largest benefits concentrated in higher-exposure urban areas. London illustrates this well. By 2050, the city accounts for around 44,200 avoided premature deaths, £2.2 billion in additional GVA and over 9 million working days gained, capturing approximately 17% of UK-wide avoided deaths despite representing around 13% of the population. The clean air dividend flows most strongly to the places where pollution is worst, creating an opportunity to ensure decarbonisation policy and investment are informed by where health burdens and potential gains are greatest.

**The findings also show why air quality co-benefits should be treated as a core part of the case for net zero delivery.** This study focuses on selected sector pathways, pollutants and health outcomes where the evidence base is strongest, but even within that defined scope the benefits are substantial. Wider impacts sit outside the core valuation, including educational outcomes, ecosystem benefits, impacts on physical capital such as buildings and materials, and some wider healthcare and productivity channels. This means the results should be read not as the full value of cleaner air, but as strong evidence that clean air benefits are material, measurable and important for appraisal.

## Wider and emerging impacts

Beyond the core valuation, the analysis points to a number of wider impacts that reinforce the broader value of cleaner air. **Net zero pathways are projected to reduce black carbon emissions by around 37% by 2050 under the combined scenario**, with decarbonisation in buildings generating the largest reductions<sup>1</sup>. The analysis also considers educational impacts linked to avoided school absences; while these are only partially monetised, **improved attendance may support longer-term educational attainment and later-life outcomes** in ways that extend well beyond the productivity effects captured here. The report additionally flags **emerging uncertainties around electricity demand from AI-related data centres**, which could affect future emissions trajectories depending on how that additional demand is met.

## Implications for policy

The findings point to a clear conclusion that **air quality co-benefits are material, measurable and should be treated as a core part of the case for net zero delivery, not an afterthought**. Health improvements, productivity gains and avoided healthcare pressures represent a significant share of the value that decarbonisation creates, but are not always fully reflected in standard appraisal frameworks. Addressing that gap would give policymakers a more complete picture of what net zero is worth.

Geography matters too. Because exposure and benefits vary so substantially across locations, **place-based targeting and local modelling can help direct investment where pollution burdens and potential gains are greatest**. Expanding the evidence base around pollutants such as black carbon, educational impacts and ecosystem effects would further strengthen future appraisals.

Clean air is one of the most immediate, tangible and economically significant dividends of the net zero transition. Recognising it more systematically in appraisal frameworks, investment decisions and the wider public case for decarbonisation would strengthen the foundation on which the UK's climate transition is built.

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<sup>1</sup> We refer to 'buildings' as the decarbonisation of residential and non-residential buildings along with electricity supply within the CCC's 7<sup>th</sup> carbon budget.

# 1 Introduction

The UK's transition to net zero is, above all, a climate imperative. However, it also presents a significant public health opportunity. As the UK decarbonises its transport, buildings, industry and electricity supply, it will also dramatically reduce the pollutants that damage lungs, shorten lives, and cost the economy billions of pounds every year. This report, commissioned by the Clean Air Fund and produced by CBI Economics and WSP, seeks to quantify that opportunity.

## 1.1 Background and policy context

The UK has committed to reaching net zero greenhouse gas emissions by 2050, with legally binding carbon budgets setting the trajectory. The Climate Change Committee's (CCC) Balanced Pathway represents the central, government-recognised route to meeting those targets, setting out how emissions across transport, buildings, industry, electricity supply and other sectors are expected to fall over the coming decades.

Air quality policy operates alongside, but often separately from, climate policy. The UK has legal obligations under domestic legislation to reduce population exposure to harmful pollutants, most notably nitrogen dioxide (NO<sub>2</sub>) and fine particulate matter (PM<sub>2.5</sub>). International benchmarks, including the World Health Organisation air quality guidelines and the European Union's revised Ambient Air Quality Directive, set more ambitious targets for air quality improvement. Despite significant progress over recent decades, air pollution remains one of the UK's most important environmental health risks. It is estimated to contribute to tens of thousands of premature deaths in the UK each year, drive chronic respiratory and cardiovascular disease, and place substantial pressure on NHS services and the wider economy<sup>2</sup>.

These two policy agendas, climate and clean air, are more closely connected than policy frameworks have historically recognised. Many of the same activities that generate greenhouse gas emissions also produce the pollutants responsible for poor air quality. Decarbonising therefore creates an opportunity to deliver climate, health and economic benefits simultaneously.

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<sup>2</sup> Royal College of Physicians (2025) [A breath of fresh air: responding to the health challenges of modern air pollution](#)

## 1.2 Why air quality co-benefits matter

Air quality improvements are among the most immediate and tangible benefits of decarbonisation. Unlike the climate benefits of emissions reductions, which accumulate globally over decades, cleaner air delivers local benefits that can be experienced within years. Reduced exposure to air pollution lowers the risk of premature mortality and illness, reduces pressure on health services and supports a healthier, more productive workforce.

Yet these benefits are often absent in public discourse surrounding the transition and remain only partially reflected in many appraisal frameworks and investment decisions. As a result, the full value of net zero delivery is often understated. Understanding the scale, timing and distribution of air quality co-benefits is therefore important for policymakers, investors and local decision-makers seeking to maximise the returns from decarbonisation.

## 1.3 Study objectives and approach

This study quantifies the air quality, health and economic co-benefits associated with selected decarbonisation pathways aligned with the CCC Balanced Pathway.

The study models four illustrative scenarios aligned with the CCC's Balanced Pathway to net zero, focusing on sectors expected to deliver the largest air quality improvements:

- surface transport;
- buildings (residential and non-residential combustion);
- industrial combustion; and
- a combined pathway across all modelled sectors.

Each sector scenario includes the same decarbonised power generation pathway, reflecting the enabling role of cleaner electricity across the wider transition.

WSP modelled annual changes in NO<sub>2</sub> and PM<sub>2.5</sub> concentrations at 1 km × 1 km resolution across the UK under each pathway. These concentrations were population-weighted using population estimates from the Office for National Statistics. Population-weighted concentration is a statistical metric that measures the average level of exposure to air pollution by giving more weight to areas where more people live, rather than taking a simple geographic average.

CBI Economics then translated these exposure reductions into health outcomes using established concentration-response functions. The primary economic valuation focuses on productivity gains from a healthier workforce, supported by supplementary estimates of avoided healthcare costs and wider welfare value using Defra appraisal approaches.

This study models how emissions reductions aligned with the CCC’s Balanced Pathway affect population exposure to air pollution, before translating those exposure changes into health impacts and economic value. The analysis follows a structured impact-pathway approach, moving from emissions changes to pollutant concentrations, population-weighted exposure, health outcomes and economic valuation. Our approach is aligned with the impact pathways approach outlined by Defra in their guidance for air quality appraisal<sup>3</sup>. Figure 1 provides a high-level summary of the modelling chain, with further methodological detail provided in **Appendix A** and the **Technical Annex**.

**Figure 1:** Modelling approach

Air quality scenarios	Exposure modelling	Health impacts	Economic valuation
<p><b>Four CCC-aligned emissions pathways are modelled to 2050.</b> Each sector scenario includes power generation, reflecting its role in enabling wider decarbonisation</p> <ol style="list-style-type: none"> <li><b>1. Surface Transport</b></li> <li><b>2. Buildings (Residential &amp; Non-residential Combustion)</b></li> <li><b>3. Industrial Combustion</b></li> <li><b>4. Combined pathway</b></li> </ol>	<p><b>WSP modelled changes in PM<sub>2.5</sub> and NO<sub>2</sub> concentrations</b> at 1 km x 1 km resolution under each pathway. These concentration changes are weighted by population to estimate <b>changes in UK-wide exposure.</b></p>	<p><b>Evidence-based concentration Response Functions (CRFs)</b> are found for a series of air quality-related health outcomes. <b>CRFs are applied to estimate the change in mortality, disease cases and hospital admissions.</b></p>	<p>Health impacts are valued through three channels</p> <ol style="list-style-type: none"> <li><b>1. Productivity</b> Impacts are converted to working-years gained and additional GVA</li> <li><b>2. Healthcare costs</b> NHS savings from avoided hospital admissions</li> <li><b>3. Welfare</b> Defra-style valuation of life-years gained and avoided illness using VOLY, QALY and willingness-to-pay approaches.</li> </ol>

<sup>3</sup> Department for Environment, Food & Rural Affairs (2026) [Air quality appraisal: impact pathways approach - GOV.UK](https://www.gov.uk/government/publications/air-quality-appraisal-impact-pathways-approach)

The analysis focuses on pollutants and health outcomes where the evidence base is strongest, particularly NO<sub>2</sub> and PM<sub>2.5</sub>. It is designed as an impact-pathway assessment rather than a full macroeconomic model and therefore does not capture wider behavioural or general equilibrium effects. Several impacts, including some pollutant pathways, educational outcomes and ecosystem effects, remain outside the quantified core valuation.

## What the quantified estimates capture

The headline results capture impacts that could be robustly quantified using established evidence and valuation approaches.

### Included in the core valuation

- mortality and life-years gained
- hospital admissions
- selected morbidity outcomes
- productivity impacts
- welfare valuation

### Partially quantified

- NHS costs avoided
- additional morbidity outcomes

### Not quantified

- health effects of alternative pollutants
- broader NHS costs
- social care costs
- ecosystem impacts
- damage to buildings and materials
- wider productivity effects such as presenteeism

As a result, the quantified findings should be interpreted as a partial estimate of the benefits associated with cleaner air, rather than a complete assessment of all potential impacts.

## 1.4 Structure of the report

**Section 2** presents the air quality modelling, including baseline concentrations and exposure changes under each scenario. **Sections 3 and 4** present the health and economic findings respectively. **Section 5** examines regional variation and presents London as an illustrative application. **Section 6** considers wider and emerging impacts of clean air, including black carbon and educational outcomes. **Section 7** concludes by setting out the implications for policy and investment.

## 2 Air quality impacts of selected decarbonisation pathways

### Key takeaways:

- **Net zero pathways reduce exposure to both NO<sub>2</sub> and PM<sub>2.5</sub>**, improving the air people breathe across the UK.
- **Surface transport delivers the largest reduction in NO<sub>2</sub> exposure**, reflecting the dominant role of road transport in UK NO<sub>x</sub> emissions.
- **Buildings and industrial combustion pathways** make particularly important contributions to **reducing PM<sub>2.5</sub> exposure**.
- **Air quality improvements build progressively through the 2030s and 2040s** as low-carbon technologies scale up across the economy.

This section presents the air quality impacts modelled by WSP under each selected decarbonisation pathway. The results are interpreted in two complementary ways. First, population-weighted exposure estimates show how average exposure changes for the people affected by pollution reductions, forming the basis for the health and economic modelling that follows. Second, the spatial distribution of concentration changes helps identify where improvements are largest and why different sectors matter for different geographic areas.

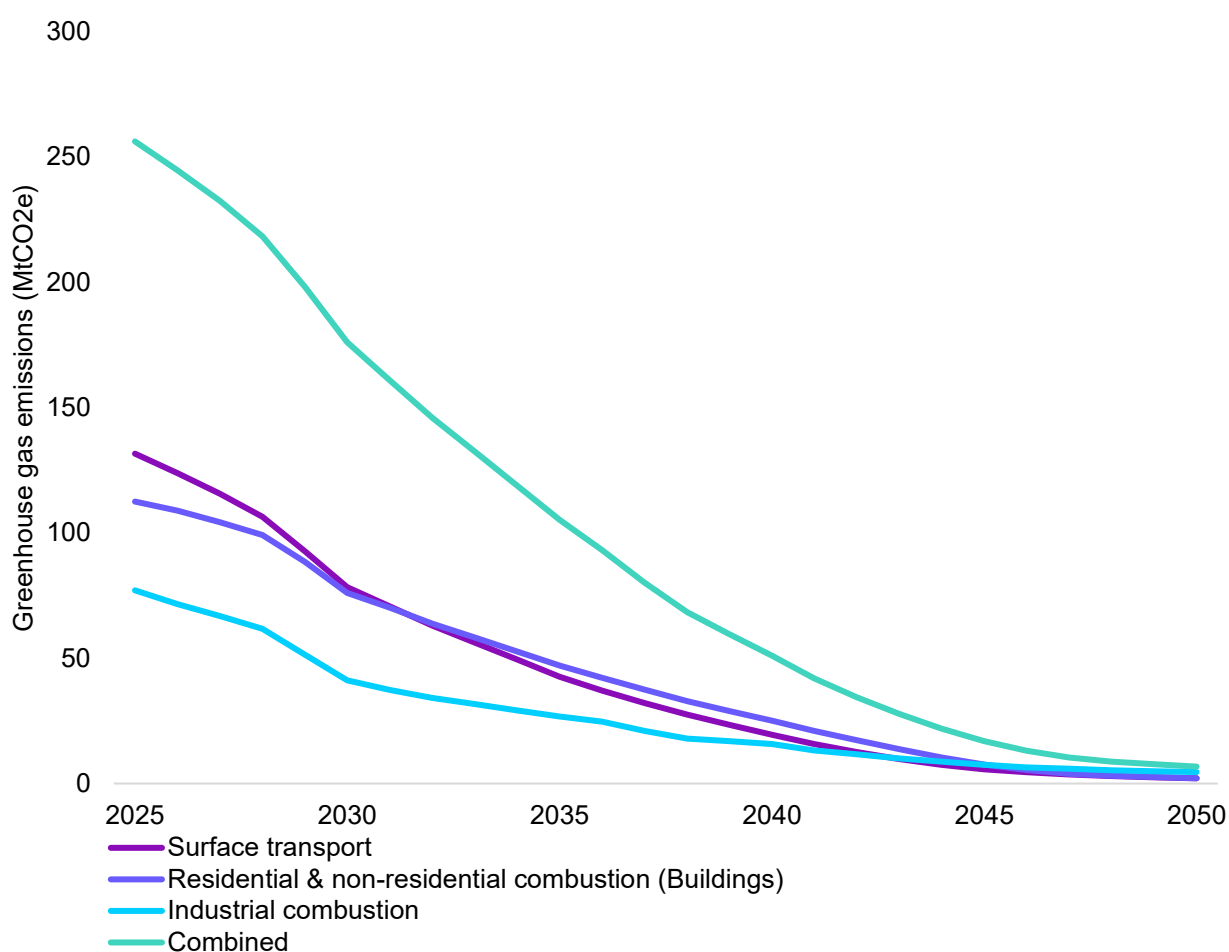


## 2.1 Emissions pathways underpinning the air quality results

As mentioned in the previous section, this analysis is anchored in the CCC's Balanced Pathway. The sectors chosen were selected where emissions reductions are expected to deliver the largest air quality improvements. This approach allows us to isolate sector-level contributions to air quality improvements and identify where the largest co-benefits arise.

**Figure 2** illustrates the trajectory of greenhouse gas emissions reductions across the three sectors modelled, each combined with the same power generation pathway.

**Figure 2: Change in sectoral emissions within the balanced pathway**



**Source:** CCC's Seventh Carbon Budget (2025), CBI Economics (2026)

Surface transport starts from the highest emissions base, reflecting the fact that it represented around 24% of UK greenhouse gas emissions in 2023, making it the single largest emitting end-use sector in the economy<sup>4</sup>. The steep decline from the late 2020s onward reflects the rapid scaling of electric vehicle uptake, with EVs projected to account for 73% of all surface transport abatement by 2050.

The buildings pathway follows a significant but more gradual trajectory, driven primarily by the rollout of heat pumps and electrification of heating. The CCC's Balanced Pathway sees around half of UK homes heated by a heat pump by 2040, compared to around 1% in 2023, with all new and replacement heating systems becoming low carbon after 2035. Industrial combustion shows the shallowest decline, consistent with the greater technical complexity of decarbonising industrial heat processes. The Balanced Pathway nonetheless sees electricity meet 61% of industrial energy demand by 2040, up from around 26% today. All three sectors approach near-zero emissions by 2050, with residual figures reflecting the harder-to-abate activities within the modelling period.

These greenhouse gas pathways provide the basis for the air pollutant emissions scenarios modelled by WSP. Using 2023 National Atmospheric Emissions Inventory (NAEI) data as the baseline, WSP scaled relevant sector emissions for NO<sub>x</sub>, PM<sub>2.5</sub> and black carbon in line with the selected CCC's Balanced Pathway assumptions. This means the air quality modelling reflects how decarbonisation changes the emissions sources most relevant to each pollutant, rather than assuming that all pollutants fall in the same way.

The pattern differs by pollutant. For NO<sub>x</sub>, surface transport delivers the largest reduction among the individual scenarios, reflecting the dominant role of road transport in current NO<sub>x</sub> emissions and the effect of electric vehicle uptake. For PM<sub>2.5</sub>, buildings delivers the largest individual reduction, reflecting the importance of heating and other combustion activity as sources of fine particulate emissions. These differences help explain the exposure results presented below.

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<sup>4</sup> Climate Change Committee (2025) *The Seventh Carbon Budget*

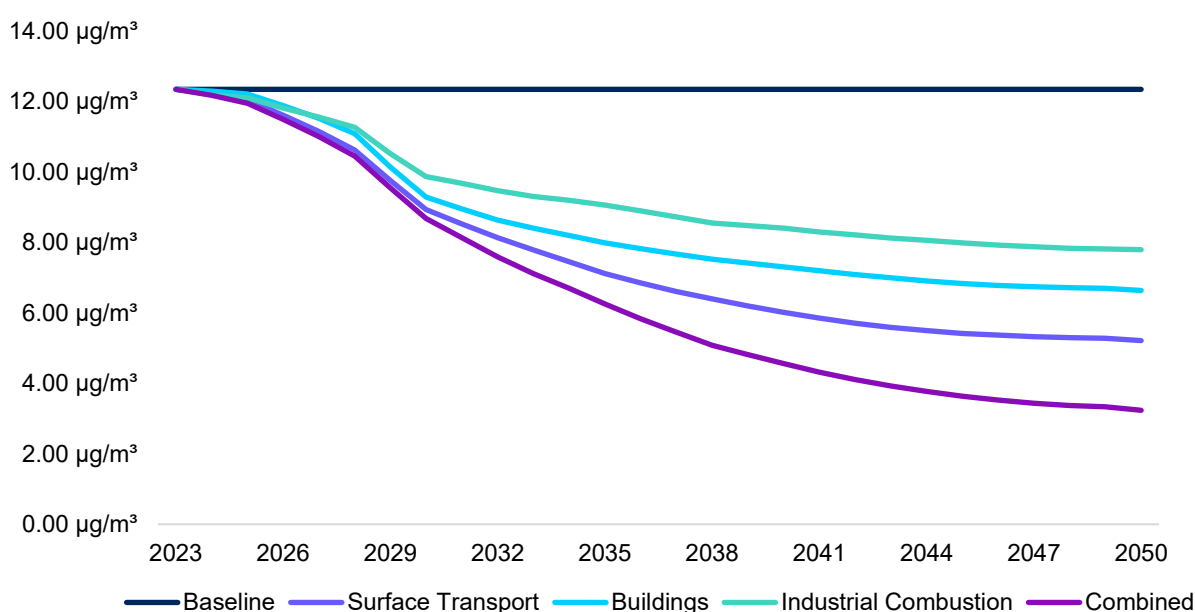
## 2.2 Changes in NO<sub>2</sub> exposure

**Figure 3** presents the population-weighted mean concentration (PWMC) for NO<sub>2</sub> under each scenario from 2023 to 2050, set against the baseline trajectory. Population-weighted concentration is used throughout the analysis as it reflects the pollution changes that people across age bands experience and gives more weight to areas where more people live, rather than simply the geographic distribution of emissions; it is therefore the key input into the health and economic modelling that follows.

The baseline PWMC NO<sub>2</sub> sits at around 12 µg/m<sup>3</sup> in 2023. Across all scenarios, the mean concentration and associated exposure falls progressively over the modelling period, but the scale and pace of reduction varies considerably by sector. Surface transport delivers by far the largest reduction in NO<sub>2</sub> exposure, with the combined scenario tracking closely alongside it. This reflects the dominant contribution of road vehicles to UK NO<sub>2</sub> emissions and the rapid uptake of low-emission vehicles projected under the CCC's Balanced Pathway. The steepest declines occur through the 2030s as electric vehicle deployment accelerates, before the rate of reduction gradually flattens as the transition approaches completion.

Buildings and industrial combustion each deliver more modest reductions in NO<sub>2</sub> exposure individually, while combustion pathways matter for overall air quality, their contribution to NO<sub>2</sub> specifically is smaller relative to transport. By 2050, the combined scenario reduces population-weighted mean concentration for NO<sub>2</sub> to approximately 4 µg/m<sup>3</sup>, representing a reduction of around two-thirds from the 2023 baseline.

**Figure 3:** Population-weighted NO<sub>2</sub> exposure by scenario



**Source:** CBI Economics / WSP (2026)

WSP's concentration modelling indicates that NO<sub>2</sub> improvements under the surface transport pathway are concentrated in larger urban areas and along major transport corridors, where road traffic emissions are highest. Under the buildings pathway, improvements are more concentrated in urban areas where building-related combustion is densest. Under the industrial combustion pathway, changes are more closely associated with industrial hotspots and clusters. A heatmap of NO<sub>2</sub> concentration across the UK by scenario is provided in **Appendix C**.

## 2.3 Changes in primary PM<sub>2.5</sub> exposure

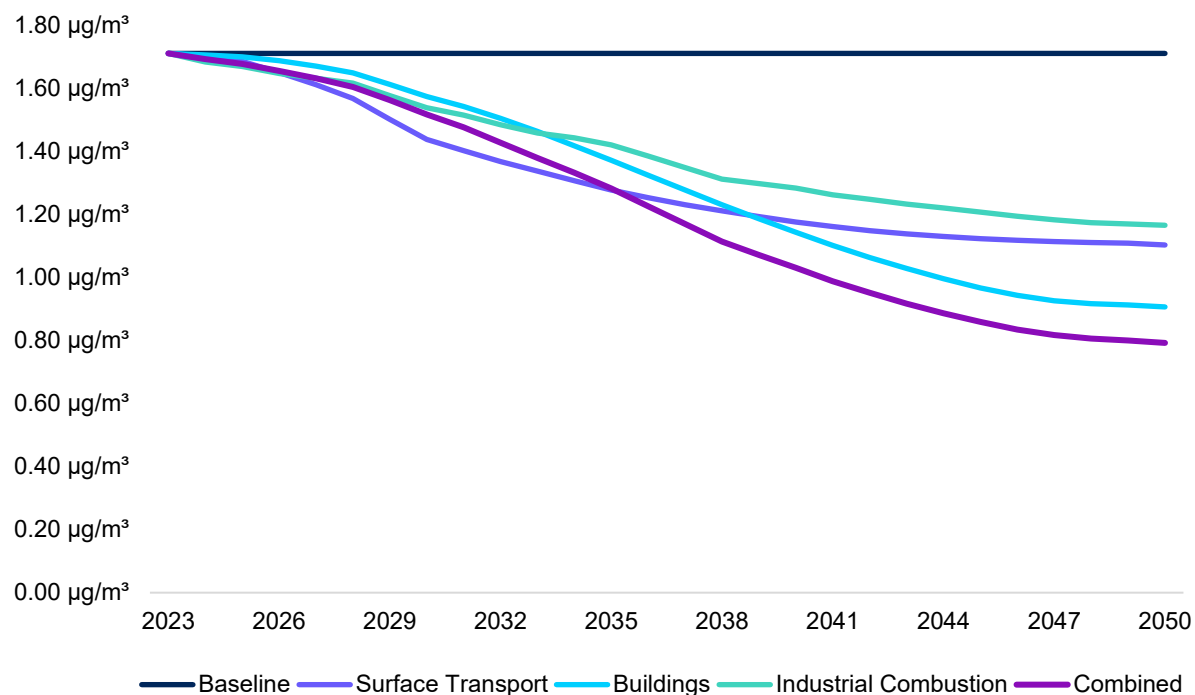
**Figure 4** presents the annual population-weighted mean concentration for primary PM<sub>2.5</sub> exposure under each scenario from 2023 to 2050. This relates purely to direct or primary emissions of PM<sub>2.5</sub>; that is, it does not include secondary or transboundary concentrations which are significant but would not change under the modelled scenarios. The baseline PWMC for primary PM<sub>2.5</sub> sits at around 1.75 µg/m<sup>3</sup> in 2023. While all scenarios deliver reductions over the modelling period, the overall scale of change is notably smaller than for NO<sub>2</sub>, and the separation between scenarios is less pronounced. This reflects the fundamentally different nature of PM<sub>2.5</sub> as a pollutant. Fine particulate matter has a wider range of contributing sources, can travel long distances through the atmosphere, and has a meaningful share of UK concentrations that originate from transboundary pollution and secondary atmospheric formation that lies outside the scope of the domestic sectoral pathways modelled in this study.

Unlike the NO<sub>2</sub> results, where surface transport is the clear dominant driver, the sector contributions to PM<sub>2.5</sub> reduction are more evenly distributed. Buildings delivers a comparable, and in some years larger, reduction in PM<sub>2.5</sub> exposure than surface transport, reflecting the significant contribution of heating-related combustion to fine particulate concentrations.

The more gradual and compressed PM<sub>2.5</sub> trajectories, compared with those for NO<sub>2</sub>, highlight an important policy implication. Reducing fine particulate exposure requires action across a wider range of emission sources, and the benefits achievable through domestic decarbonisation alone are limited by the substantial share of PM<sub>2.5</sub> originating outside the UK. International efforts to reduce emissions could therefore deliver additional reductions in PM<sub>2.5</sub> exposure for the UK, although these effects are not quantified in this study.

Nevertheless, domestic policy remains an important lever for improving air quality. Combustion-focused pathways are particularly significant because they target some of the largest domestically controllable sources of PM<sub>2.5</sub>. As a result, they can deliver meaningful reductions in population exposure, even when transboundary contributions remain difficult to address.

**Figure 4:** Population-weighted PM<sub>2.5</sub> exposure by scenario



**Source:** CBI Economics / WSP (2026)

WSP’s spatial modelling indicates a similar but more compressed pattern for PM<sub>2.5</sub> than for NO<sub>2</sub>. Improvements are still most visible in larger towns and cities, where baseline concentrations and population density are higher, but the overall changes are smaller. Under the surface transport pathway, PM<sub>2.5</sub> improvements are less pronounced than NO<sub>2</sub> improvements because road transport is a less dominant source of PM<sub>2.5</sub> emissions than NO<sub>x</sub> emissions. By contrast, buildings generates more visible PM<sub>2.5</sub> improvements in dense urban areas, reflecting the role of heating and other building-related combustion. Industrial combustion improvements are more closely associated with point sources and can be important locally, even where their population-weighted national effect is smaller. A heatmap of the annual average concentrations of PM<sub>2.5</sub> within the UK across each scenario is provided in **Appendix C**.

## 2.4 Interpreting the results

The exposure changes presented in **Sections 2.2** and **2.3** provide a robust and transparent picture of the air quality improvements achievable under the CCC Balanced Pathway across the sectors modelled. However, they should be read as a partial estimate of the full air quality benefits of net zero delivery, for several reasons.

The analysis covers NO<sub>2</sub> and PM<sub>2.5</sub> only. Other pollutants, including PM<sub>10</sub>, tropospheric ozone, sulphur dioxide and black carbon, are not quantified within the core modelling framework. Each of these has documented effects on human health and the wider environment, and reductions in combustion and transport activity under the Balanced Pathway would be expected to reduce their concentrations alongside those of NO<sub>2</sub> and PM<sub>2.5</sub>. Their exclusion from the core valuation reflects the need to focus on pollutants where the evidence base for concentration-response functions and economic valuation is strongest, but it means the results presented here understate the true breadth of air quality improvement that decarbonisation would deliver. Black carbon, for example, is considered separately in **Section 6**.

The concentration modelling also focuses on annual average NO<sub>2</sub> and primary PM<sub>2.5</sub>. It does not quantify the full range of pollutants that may change under net zero pathways, nor does it capture all possible air quality effects associated with changes in atmospheric chemistry.

The scenarios modelled represent three sectors from within the Balanced Pathway, each paired with the same power generation trajectory. They do not cover the full range of emissions changes implied by economy-wide net zero delivery. Sectors including agriculture, waste, aviation and shipping are not captured, and the analysis does not model transboundary emissions reductions that may result from coordinated international decarbonisation which is particularly relevant for PM<sub>2.5</sub>.

The modelling also operates at a 1 km x 1 km resolution, which, while granular by national standards, smooths over variation at the neighbourhood level. In the most heavily polluted streets and communities, particularly those close to major roads or industrial sites, actual exposure changes may be larger than the grid-level averages suggest. This means the modelling is well suited to national and regional comparison, but is not designed to capture street-level exposure gradients. In practice, concentration changes near busy roads, junctions or industrial sources may differ from the grid-cell average shown in the model outputs.

## 3 Health benefits of cleaner air

### Key takeaways:

- Cleaner air is projected to avoid nearly **264,000 premature deaths by 2050**, with long-term health benefits continuing to accrue in the future.
- The combined pathway generates almost **2,800,000 life-years gained by 2050** – equivalent to over 1 billion additional days of life across the UK.
- Around **497,000 respiratory and cardiovascular hospital admissions are avoided**, easing pressure on healthcare services and reducing illness-related disruption for individuals and families.
- Cleaner air delivers more than **38 million additional working days by 2050** – equivalent to around 168,000 full-time working years returned to the economy.
- Health benefits continue to accrue beyond 2050 as reductions in chronic disease burdens are realised over time.

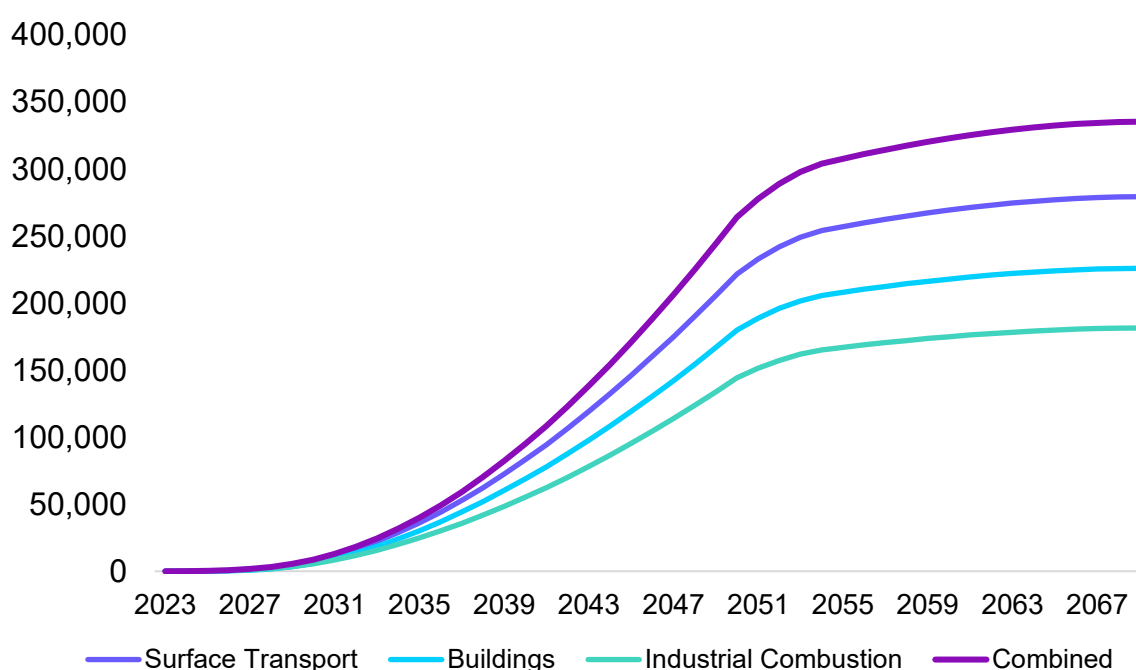
### 3.1 Avoided premature mortality

Avoided premature mortality is one of the central health benefits estimated in the model. Long-term exposure to air pollution is associated with increased mortality risk, particularly through cardiovascular and respiratory pathways. Reductions in pollutant concentrations therefore reduce the risk of premature death and generate additional life years across the population<sup>5</sup>.

<sup>5</sup> Royal College of Physicians (2025), *A breath of fresh air: responding to the health challenges of modern air pollution*

In this analysis, premature mortality impacts are estimated using the modelled change in population exposure to NO<sub>2</sub><sup>6</sup>. The combined scenario produces the largest mortality benefit because it brings together emissions reductions across the selected sectors. Under the combined scenario, nearly 264,000 premature deaths are avoided by 2050, translating to over 2.7 million life-years gained in the same time period. However, the health benefits of improved air quality continue to accrue beyond 2050 due to the lag between changes in exposure and mortality outcomes. As a result, a further 71,000 premature deaths are estimated to be avoided between 2050 and 2069 taking the total to 335,000 avoided deaths within the forecast horizon, equivalent to just over 3.5 million life years saved.

**Figure 5:** Cumulative avoided deaths by scenario



**Source:** CBI Economics modelling (2026)

**Notes:** Cumulative avoided deaths represent the total number of deaths avoided relative to the baseline pathway. The chart includes lagged mortality benefits realised after 2050 from exposure reductions occurring during the modelling period.

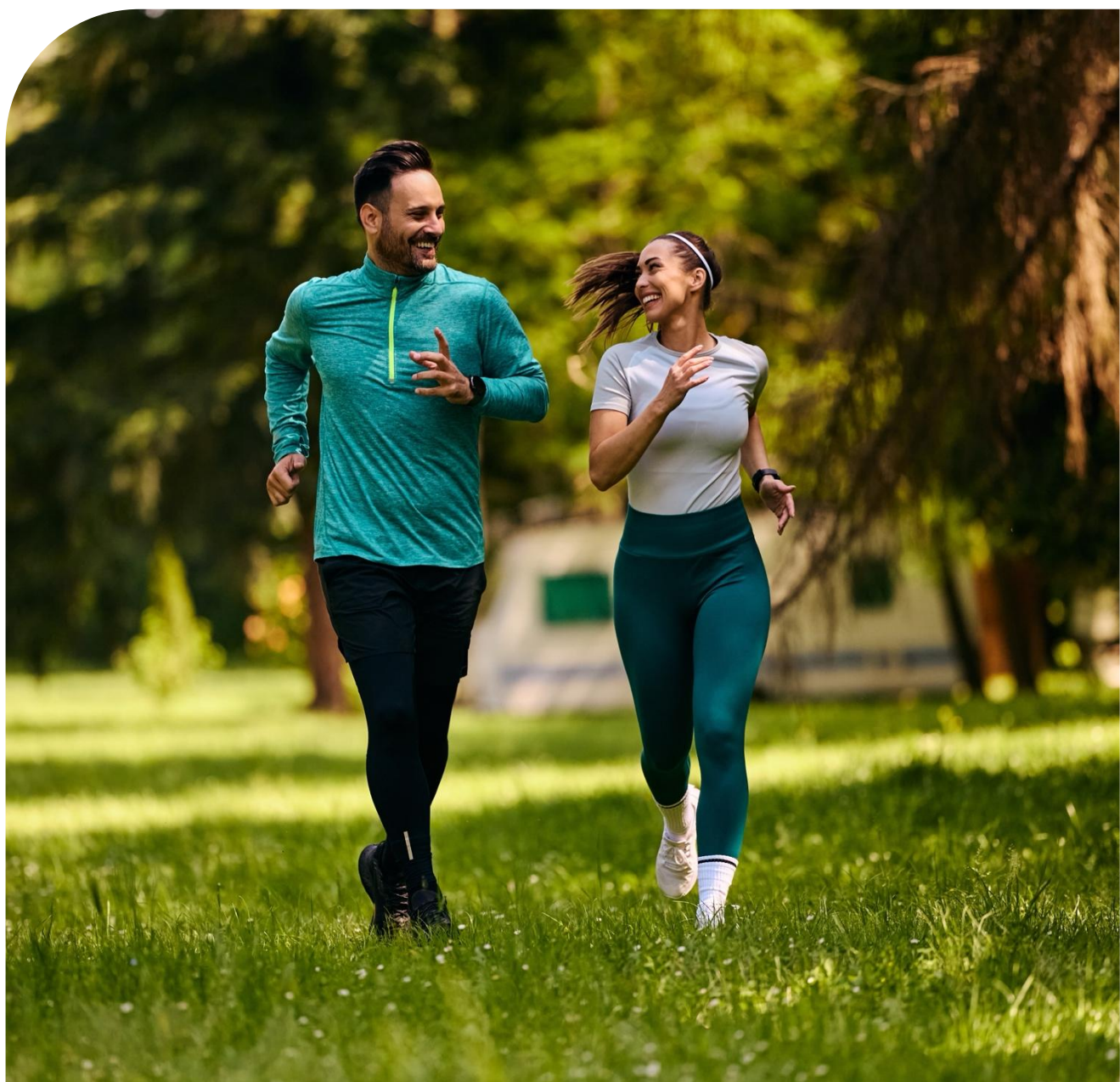
<sup>6</sup> Avoided deaths are modelled using concentration-response functions for NO<sub>2</sub> only, to avoid double counting with PM<sub>2.5</sub>. NO<sub>2</sub> is used because it produces the larger estimated mortality impact in this analysis. Given the overlap between NO<sub>2</sub> and PM<sub>2.5</sub> exposure, the resulting mortality estimates should be interpreted as reflecting the overall mortality effect associated with reduced air pollution, rather than being attributable solely to NO<sub>2</sub>.

### 3.2 Morbidity impacts

Alongside avoided premature mortality, the model estimates a range of morbidity impacts, reflecting reductions in non-fatal health outcomes such as illness and disease, associated with reduced exposure to NO<sub>2</sub> and PM<sub>2.5</sub>. These outcomes show that the health benefits of cleaner air extend beyond mortality and include substantial reductions in illness and pressure on health services.

The morbidity impacts vary by pollutant and health pathway. In this analysis, larger modelled reductions in NO<sub>2</sub> mean that NO<sub>2</sub>-related outcomes account for some of the largest effects, particularly for hospital admissions and asthma. PM<sub>2.5</sub>-related benefits are spread across a wider set of chronic disease outcomes, including IHD, stroke, COPD, dementia and diabetes.

The table below outlines the mortality and morbidity impacts across all health outcomes modelled. Core and sensitivity health outcomes are shown separately in **Appendix B**



**Table 1:** Modelled cumulative health impacts by 2050, by scenario

Avoided health outcome	Surface Transport	Buildings	Industrial combustion	Combined scenarios
<b>Core health outcomes</b>				
Deaths – NO <sub>2</sub>	221,754	179,843	144,217	264,155
IHD (Coronary heart disease) – PM <sub>2.5</sub>	17,349	17,674	13,732	21,401
Stroke – PM <sub>2.5</sub>	15,622	15,848	12,462	19,087
Respiratory hospital admissions – NO <sub>2</sub>	193,656	156,470	121,477	237,404
Cardiovascular hospital admissions – NO <sub>2</sub>	213,344	171,952	135,229	259,559
<b>Sensitivity health outcomes</b>				
Adult asthma – NO <sub>2</sub>	260,408	213,559	159,804	324,909
Child asthma – NO <sub>2</sub>	126,203	102,397	76,783	156,707
COPD – PM <sub>2.5</sub>	16,905	14,980	12,666	18,874
Dementia – PM <sub>2.5</sub>	76,729	69,366	59,087	85,617
Diabetes – PM <sub>2.5</sub>	18,843	16,765	14,059	21,164
School days – PM <sub>2.5</sub>	1,942,497	2,038,116	1,517,267	2,483,427

**Source:** CBI Economics

**Notes:** Values shown are modelled estimates of benefits realised by 2050 and are presented as unrounded model outputs. Core outcomes are shown separately from sensitivity outcomes. School days are measured in days; all other morbidity endpoints are measured as cases or admissions.

The clean air dividend of net zero:

Air quality, health and economic co-benefits from selected UK decarbonisation pathways

Under the combined scenario, the model estimates around 237,000 avoided respiratory hospital admissions and 260,000 avoided cardiovascular hospital admissions by 2050. These are core health outcomes and reflect reductions in acute pressure on health services associated with cleaner air.

The model also estimates substantial avoided disease incidence by 2050 and beyond. In the combined scenario for core health outcomes, this includes around 21,400 avoided IHD cases and 19,100 avoided stroke cases by 2050.

Sensitivity outcomes suggest that the wider health benefits could be larger. Under the combined scenario, the model estimates 325,000 avoided adult asthma cases and 157,000 avoided child asthma cases. Other additional morbidity outcomes include COPD, dementia, diabetes incidence and school days lost. These results are useful for understanding the wider potential scale of benefits but should be interpreted more cautiously than the core results.

Sector patterns differ across outcomes. Surface transport tends to drive large NO<sub>2</sub>-related benefits, particularly for hospital admissions and asthma, because transport emissions are concentrated in populated areas. Buildings contributes strongly to several PM<sub>2.5</sub>-related morbidity endpoints, while industrial combustion also contributes but generally delivers smaller population-weighted benefits.

Overall, the morbidity results show that cleaner air reduces a broad range of health burdens, not only premature mortality. The core results provide the most defensible estimate of morbidity benefits, while the sensitivity outcomes indicate that the full health gains from cleaner air may be wider than the headline figures alone.



### 3.3 Timing and distribution of impacts

The health benefits from cleaner air are not distributed evenly over time or across places. They depend on when emissions reductions occur, where concentration changes are largest, how many people are exposed, and how quickly each health outcome responds to lower pollution.

A key feature of the results is that benefits build cumulatively over time. As emissions fall under the CCC-aligned pathways, exposure reductions increase and annual health benefits become larger. The cumulative impact therefore reflects repeated annual benefits from lower exposure compared with the baseline pathway, as well as lagged benefits from earlier exposure reductions.

The core modelling period runs from 2023 to 2050, reflecting the period over which emissions and exposure changes are modelled. Some health impacts are realised within the same year, while others, including mortality and some chronic morbidity outcomes, are subject to lag assumptions, as set out in the [Technical Annex](#). This means that some benefits generated by exposure reductions before 2050 continue to accrue beyond 2050, with lagged effects realised up to 2070. These are lagged benefits from the modelled pathway, not additional post-2050 exposure reductions or sustained lower exposure after 2050.

Geography also affects the distribution of impacts. The model uses population-weighted exposure because the health impact of a concentration reduction depends on how many people experience it. Reductions in polluted, densely populated areas therefore have a larger health effect than equivalent reductions in less populated areas. This also has implications for inequalities, as exposure and baseline health vulnerability are not evenly distributed across the population<sup>7</sup>. **Section 5** explores these spatial patterns in more detail, using London as an illustrative case study.

Overall, the timing and distribution of impacts underline two important points. First, air quality improvements deliver both near-term and longer-term health benefits, with some benefits continuing beyond the core modelling period. Second, the largest health gains are likely to arise where emissions reductions occur in or near densely populated areas, reinforcing the importance of place-based clean air and decarbonisation policy.

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<sup>7</sup> Gray et al (2023) [Deprivation based inequality in NOx emissions in England - Environmental Science: Advances \(RSC Publishing\)](#)

## 4 Economic value of cleaner air

### Key takeaways:

- Cleaner air supports economic output by **improving workforce health, reducing illness-related absence and extending working lives.**
- Under the combined pathway, **cumulative productivity gains reach £153 million by 2030, £2.4 billion by 2040 and £7.7 billion by 2050.**
- By 2050, cleaner air generates **£625 million in annual additional GVA**, meaning productivity benefits continue year after year as exposure remains lower.
- These results show that air quality co-benefits should be considered more consistently in appraisal and investment decisions, as they form part of **the wider economic return from decarbonisation.**

### 4.1 Valuing the economic benefits of cleaner air

This section values the health impacts set out in **Section 3**. The main focus is the productivity uplift: the additional GVA generated through improved workforce health. This captures the ways in which cleaner air can affect economic output through the labour market, including fewer illness-related absences, longer working lives and avoided impacts on informal carers' ability to work.

The productivity valuation is built from the health outcomes modelled in the previous section. For short-term illness and some morbidity outcomes, the model estimates avoided working days lost. For more severe conditions, it captures longer-term changes in labour market participation, including delayed retirement or avoided withdrawal from work. For mortality, avoided premature deaths generate future working years, which are valued using GVA per worker. Together, these channels estimate how reductions in air pollution exposure can translate into additional productive capacity in the economy.

Alongside the headline productivity result, the report presents two supplementary valuation perspectives. Healthcare savings capture avoided NHS costs from reduced respiratory and cardiovascular hospital admissions. Welfare valuation captures the wider social value associated with improved health, quality of life and reduced mortality risk. These measures complement the productivity results by illustrating how the benefits of cleaner air extend beyond workforce and economic outcomes alone.

The valuation routes should not be added together. They capture different types of value and may overlap conceptually, particularly where welfare values capture aspects of illness, quality of life or mortality risk that also affect work and healthcare use. The results are therefore reported separately, with productivity presented as the headline economic output measure and healthcare and welfare values used as supporting valuation perspectives.

All monetary results are reported in real £2023 present-value terms. This means that future benefits are converted into today's price terms and discounted to reflect when those benefits occur. Further detail on discounting and endpoint-specific valuation assumptions is provided in the [Technical Annex](#).

## 4.2 Productivity gains from a healthier workforce

Under the combined scenario, cleaner air generates an estimated £7.7 billion in cumulative additional GVA by 2050. This reflects the economic value of improved workforce health, including fewer illness-related absences and longer working lives. By 2050, the cumulative productivity gain is comparable to the annual contribution of the UK's music industry to the economy, which generated £8 billion in GVA in 2024<sup>8</sup>.

The productivity gains build progressively throughout the transition. By 2030, cumulative additional GVA reaches £153 million, rising to £2.4 billion by 2040 and £7.7 billion by 2050. This reflects both the increasing scale of emissions reductions as low-carbon technologies are deployed and the fact that health improvements accumulate over time. Cleaner air therefore generates economic returns well before the UK reaches net zero, with a substantial share of the total benefit realised within current policy and investment horizons.

The cumulative results are complemented by growing annual productivity gains. By 2050 alone, cleaner air is estimated to generate approximately £625 million in additional GVA per year, reflecting the ongoing benefits of a healthier workforce. These annual gains continue beyond the initial implementation of emissions reductions because lower pollution exposure results in sustained improvements in health and labour market participation.

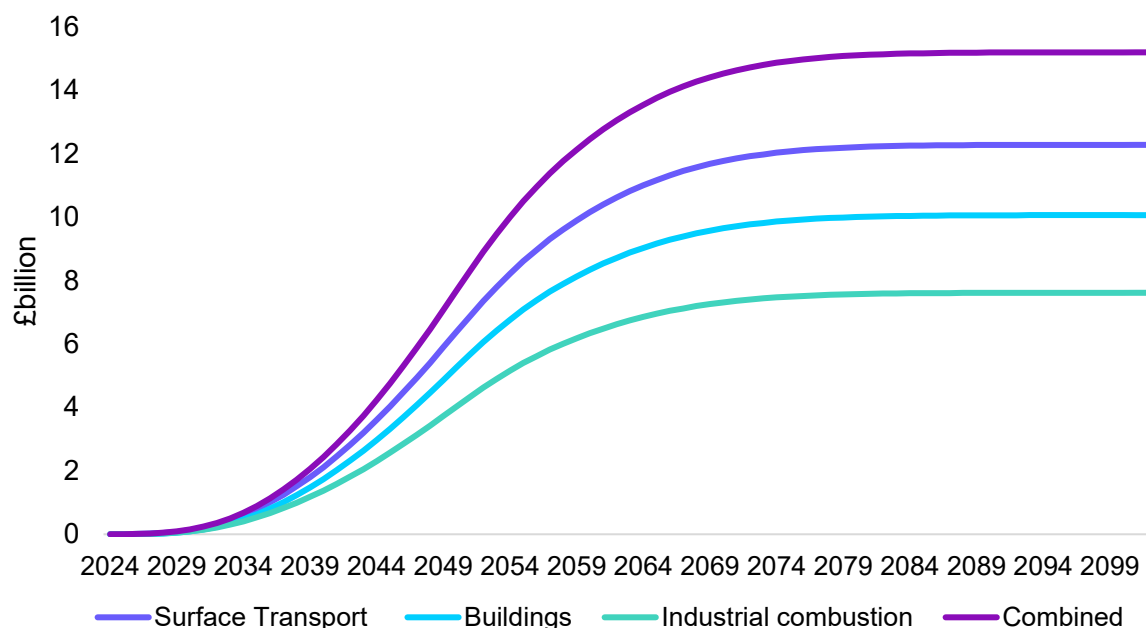
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<sup>8</sup> UK Music (2025) [This is Music](#)

These productivity gains are underpinned by substantial labour market effects. Under the combined scenario, cleaner air generates more than 38 million additional working days by 2050, equivalent to approximately 168,000 full-time working years returned to the economy. The benefits arise across multiple health pathways, including avoided illness-related absences, improved labour market participation and additional working years generated through reductions in premature mortality.

Productivity gains vary by pathway, reflecting the different exposure reductions generated across sectors. Surface transport delivers the largest productivity uplift among the individual pathways, driven by substantial reductions in NO<sub>2</sub> exposure as road transport decarbonises. Buildings and industrial combustion also generate meaningful gains through reductions in PM<sub>2.5</sub> exposure. **Figure 6** shows how productivity gains build over time across the modelled pathways. The time horizon over which these benefits materialise is important. The chart captures productivity gains generated by exposure reductions up to 2050, including lagged effects from earlier improvements in air quality such as working years gained being realised later. It does not capture the additional benefits that could arise if lower exposure levels are sustained beyond 2050.

**Figure 6:** Cumulative productivity accrual, GVA, £bn, 2023 prices



**Source:** CBI Economics (2026)

**Notes:** Cumulative additional GVA generated by the year the work year gained is worked in.

Under the combined scenario, the productivity results are supported by two additional valuation perspectives. Reduced hospital admissions are estimated to save £720 million in NHS costs by 2050. This estimate captures only selected hospital admissions and excludes wider costs such as GP appointments and primary care, outpatient treatment, prescription medicines, rehabilitation services and long-term disease management. Welfare valuation is significantly larger, at £114 billion by 2050. This reflects a broader measure of social value, including life years gained, avoided illness and improvements in quality of life. In the combined scenario, this includes the welfare value of almost 2.8 million life years gained by 2050, alongside avoided morbidity valued using Defra-style VOLY, QALY and willingness-to-pay approaches.

These results provide additional perspectives on the benefits of cleaner air, but should be interpreted separately because they capture different forms of value and are not directly additive. The combined scenario results are therefore best understood as distinct valuation lenses on the same underlying improvement in health: cleaner air can strengthen the labour market, reduce pressure on public services and generate wider wellbeing gains.

### 4.3 Implications for appraisal and investment

The valuation results show that air quality co-benefits are material and should be considered more systematically in appraisal and investment decisions. Under the combined scenario, cleaner air generates sizeable productivity benefits by 2050. These benefits are not incidental to decarbonisation: they form part of the wider economic and social return from policies that reduce air pollutant emissions.

This matters because air quality benefits are sometimes treated as secondary to the core climate case, or captured only partially through avoided healthcare costs and welfare valuation. The results in this report show that the economic implications are wider. By supporting a healthier workforce, cleaner air can contribute directly to economic output, while also reducing pressure on public services and improving wellbeing. Appraisal that excludes these channels risks understating the value of clean energy, transport, heat and industrial policy.

Incorporating air quality co-benefits more consistently would provide decision-makers with a fuller assessment of the returns from decarbonisation. It would also help identify where climate action can deliver the greatest public health and economic gains, particularly where emissions reductions occur close to large or more exposed populations.

## 5 Why place matters

### Key takeaways:

- **Air quality co-benefits are not distributed evenly across the UK;** the largest gains occur in areas with the highest pollution exposure.
- **London captures a disproportionate share of health and economic benefits** because of its elevated baseline pollution levels.
- Local pollution sources influence which decarbonisation pathways deliver the greatest benefits.
- **Place-based analysis can help target investment** where health burdens and potential gains are greatest.

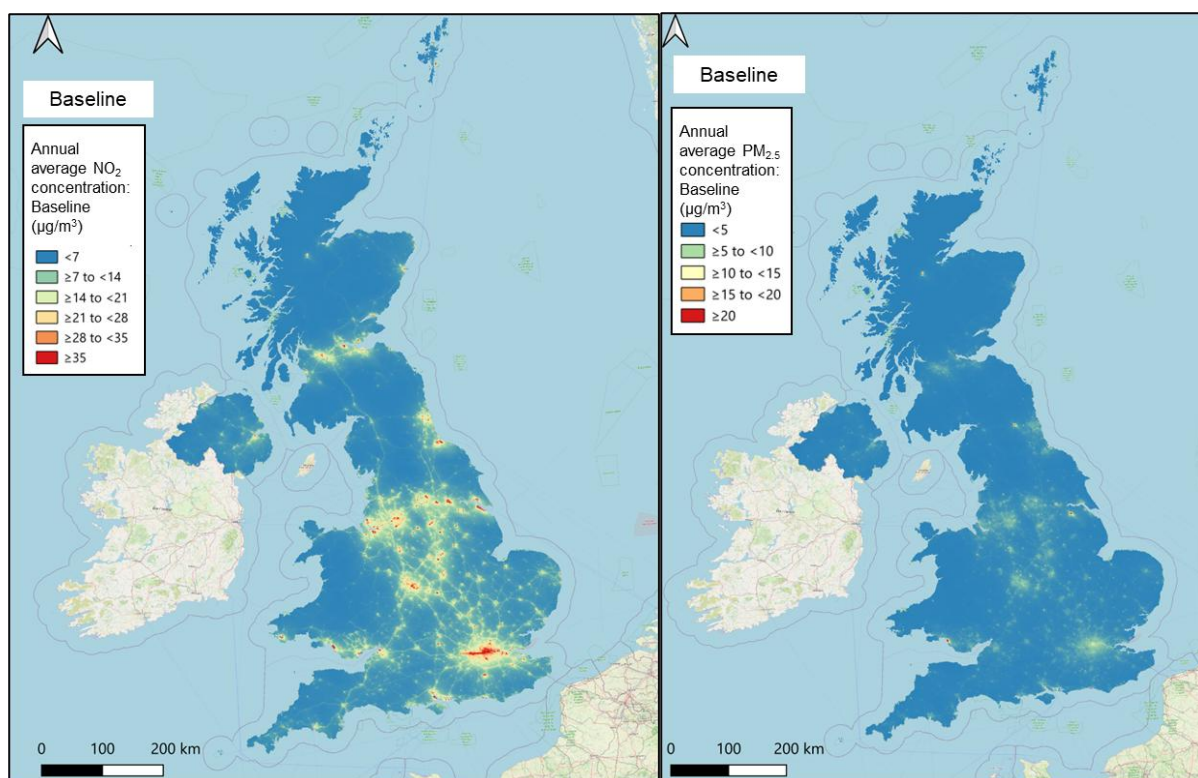
### 5.1 Air quality co-benefits are not evenly distributed

The UK-wide results presented in preceding sections provide a robust picture of the aggregate scale of air quality co-benefits achievable under various CCC Balanced Pathway scenarios. However, national headline figures mask significant variation in both baseline pollution exposure and the distribution of resulting health and economic gains across different parts of the country. Understanding this geographic dimension is essential for translating national co-benefit estimates into actionable insight for policymakers, local authorities, and those responsible for targeting investment and intervention.

Air pollution is not experienced uniformly across the UK. Baseline concentrations of NO<sub>2</sub> and PM<sub>2.5</sub> are substantially higher in densely populated urban areas, along major transport corridors, and in locations with high industrial activity. Because the health and economic co-benefits of emissions reductions are directly related to the scale of exposure change, areas with higher baseline concentrations stand to gain disproportionately from the transition to a low-carbon economy. This means the 'clean air dividend' is more concentrated where pollution burdens are the greatest.

Recognising this geography is important for three reasons. First, it enables policymakers to understand where the largest health and productivity gains are available and to direct investment accordingly. Second, it highlights the potential for clean air policies to address, rather than entrench, existing regional inequalities in health outcomes. Third, it underscores that the relative importance of different policy pathways varies by location and should inform local delivery strategies.

**Figure 7:** Baseline average annual concentrations of NO<sub>2</sub> (left) and primary PM<sub>2.5</sub> (right) within the UK



Source: WSP (2026)

**Figure 7** maps the 2023 baseline concentrations of NO<sub>2</sub> and primary PM<sub>2.5</sub> across the UK. Areas of elevated pollution are concentrated in major urban centres, particularly London, the West Midlands, Greater Manchester and other large conurbations, as well as along key motorway and arterial road networks. By contrast, much of rural England, Wales, Scotland and Northern Ireland experiences substantially lower concentrations. WSP’s concentration modelling indicates that NO<sub>2</sub> hotspots are closely associated with dense road networks and major transport corridors, whereas PM<sub>2.5</sub> exhibits a more diffuse spatial pattern across the country.

These patterns reflect the distribution of population, economic activity and emissions sources. Urban areas combine several factors associated with higher pollutant concentrations, including high traffic volumes, dense residential and commercial development, greater heating demand and, in some locations, industrial activity. As a result, NO<sub>2</sub> concentrations are typically highest at roadside locations and along major transport routes. PM<sub>2.5</sub>, by contrast, is influenced by a broader mix of local combustion sources and atmospheric transport, producing a more widespread pattern that broadly mirrors the UK's settlement and infrastructure network and places the highest exposure burden on the most densely populated communities.

## 5.2 London as an illustrative example

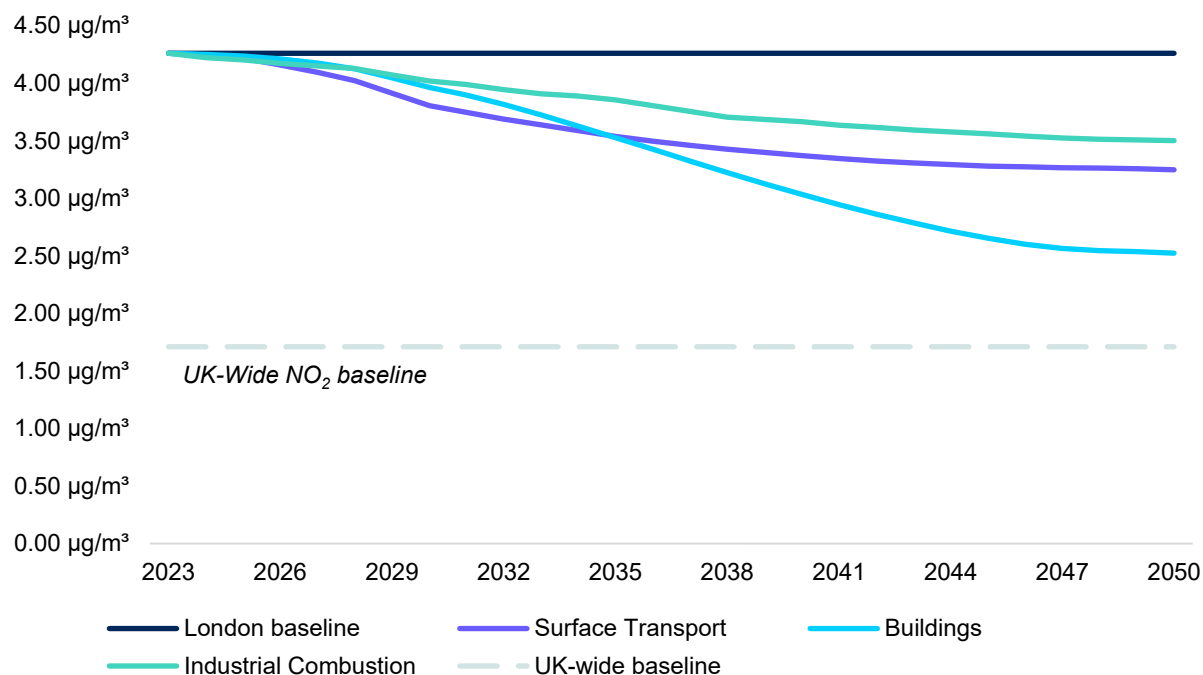
London provides an instructive case study for understanding how local exposure patterns shape the distribution of air quality co-benefits. The city's baseline NO<sub>2</sub> and PM<sub>2.5</sub> concentrations sit substantially above the UK population-weighted average, driven by its high population density, intensive road transport network, and the volume of residential and commercial combustion activity. This elevated baseline means that equivalent reductions in emissions translate into larger changes in exposure per person than the national average would suggest.

WSP's London concentration modelling indicates that the spatial pattern of improvements differs by pathway. Surface transport reductions are most visible along major roads and transport corridors, while buildings reductions are concentrated in denser areas where building-related combustion is highest. Industrial combustion impacts are more localised around point sources and less concentrated in central London. These patterns help explain why London's pathway ranking differs from the UK-wide results. In a dense urban area, building-related combustion can generate particularly large exposure benefits.

**Figures 8 and 9** overleaf present annual mean population-weighted exposure reductions for primary PM<sub>2.5</sub> and NO<sub>2</sub> respectively, compared against the UK baseline. Both charts illustrate that London's starting point is far above the national average. Across the entire forecast horizon, and under every scenario modelled, exposure levels in London never fall to the UK baseline, underscoring the scale of the city's pollution burden relative to the rest of the country.

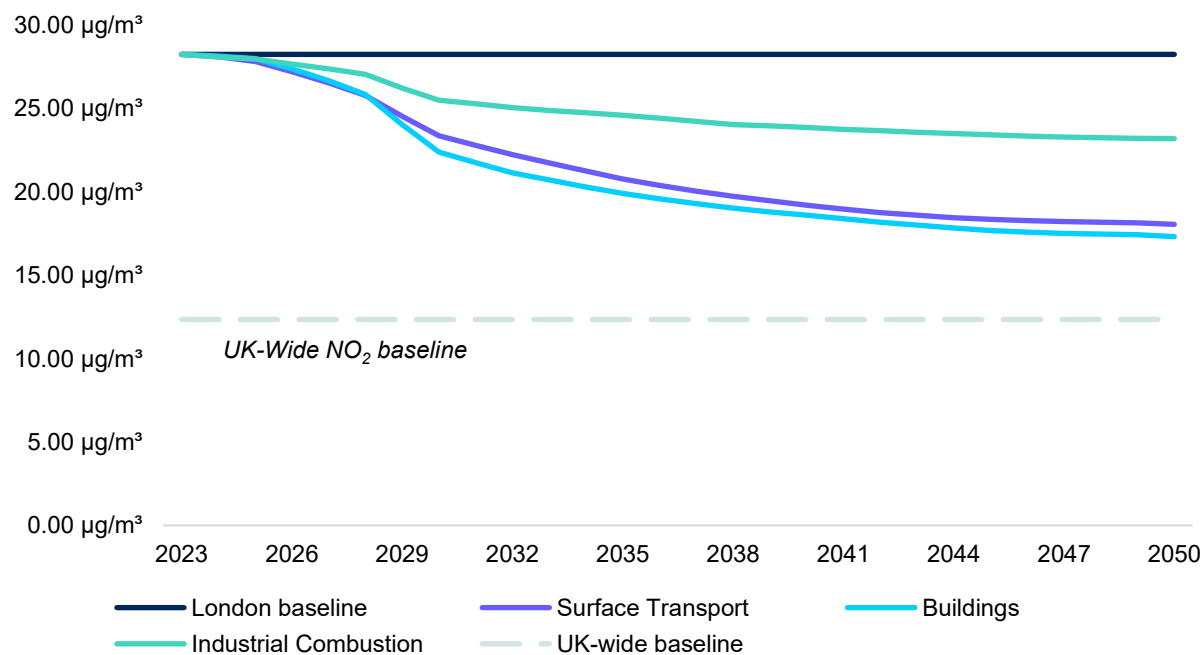
The charts also reveal an important divergence from the UK-wide results. Nationally, surface transport decarbonisation delivers the largest air quality gains. In London, however, the buildings pathway generates larger reductions in exposure, reflecting the particular weight of heating and other combustion sources in a dense urban environment. This exemplifies why national headline results should not be read as a universal ranking of policy importance. Different places have different source profiles, so pathways that appear smaller at a national level may be especially important locally. Realising the full clean air dividend therefore depends on progress across the full mix of decarbonisation policies, not only those that deliver the largest aggregate national gains.

**Figure 8:** Population-weighted PM<sub>2.5</sub> exposure by scenario



Source: CBI Economics / WSP (2026)

**Figure 9:** Population-weighted NO<sub>2</sub> exposure by scenario



Source: CBI Economics / WSP (2026)

### 5.3 London's health and economic co-benefits

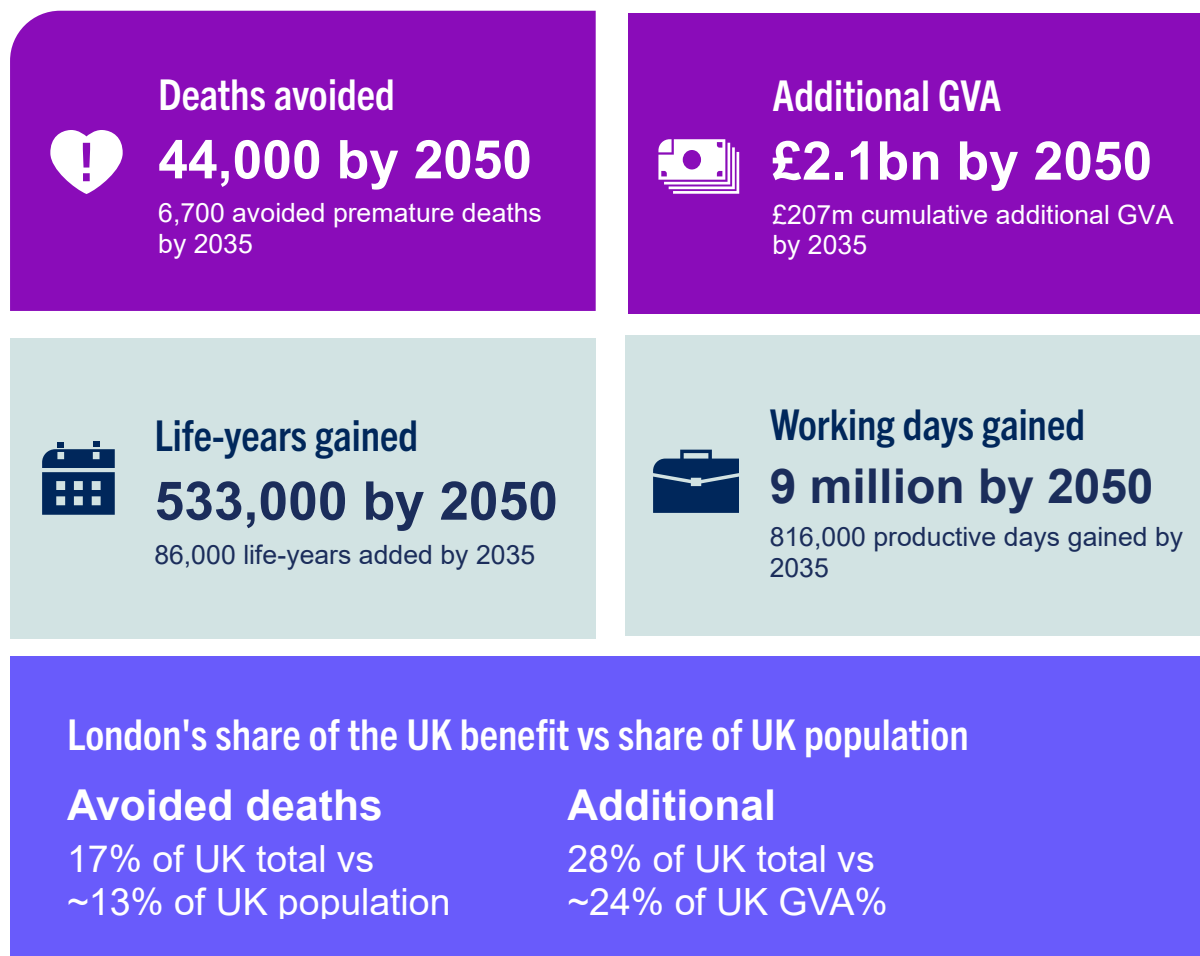
To understand what the transition to a low-carbon economy could mean specifically for London, we apply the same methodology used for the UK-wide analysis to model the air quality co-benefits of the CCC Balanced Pathway at a city level. The London results are based on the same WSP concentration modelling framework used for the UK-wide analysis, applied to London-specific exposure outputs. This analysis is an indicative application of the national modelling framework to London-specific concentration data, designed to illustrate how local exposure patterns shape the scale and composition of co-benefits, rather than a bespoke local model built from the ground up.

The national model applies population-weighted average parameters that smooth over within-city variation, and the economic valuation draws on UK-wide unit values that do not reflect London's higher wages, labour force participation, and productivity per worker. For these reasons, the London results should be interpreted as an indicative application of the national modelling framework, rather than as a fully bespoke city-level valuation. They are useful for illustrating how higher baseline exposure and local economic conditions can shape the scale of co-benefits, but should not be read as a complete estimate of London's potential gains.

Nevertheless, the picture that emerges is a compelling one. London's elevated baseline pollution levels mean that the health and economic returns from reducing emissions are proportionally greater than for the UK, shown in **Figure 10**. The combined scenario points to gains that are substantial in their own right and that carry significant implications for how London plans, invests in, and makes the case for accelerating decarbonisation.



**Figure 10:** London air quality co-benefit summary findings for the combined scenario



Because London's baseline pollution levels sit well above the national average, the city captures a disproportionate share of UK-wide air quality co-benefits relative to its size. By 2050, in the combined scenario, the modelling points to an estimated 44,000 avoided premature deaths, 533,000 life-years gained, 9 million additional working days, and £2.1 billion in additional GVA. Placing these figures in a national context exemplifies the importance of targeted intervention. London accounts for around 17% of avoided premature deaths nationally despite representing approximately 13% of the UK population. It also accounts for around 28% of modelled UK productivity gains, reflecting the scale of London's modelled air quality improvements and associated health impacts.

## 5.4 What London tells us about place-based policy

London is not unique in experiencing these dynamics. Rather, it provides a clear illustration of a wider pattern observed across the UK: areas with higher baseline pollution levels capture disproportionately large health and economic gains from decarbonisation. The implication is that place matters. National averages are useful for understanding overall scale, but local exposure patterns determine where the greatest benefits arise and therefore where interventions may deliver the highest returns.

The analysis in this section points to a clear message for policymakers. The benefits of cleaner air are not spread evenly, and that unevenness should shape how investment and intervention are prioritised. Communities in high-pollution areas stand to gain the most from decarbonisation, and urban authorities have a strong evidence base for making the case that targeting clean air investment in pollution hotspots delivers the greatest returns in terms of avoided mortality, reduced morbidity, and productivity gains. Co-benefits concentrating where exposure is greatest means that achieving the CCC Balanced Pathway has the potential to narrow longstanding geographic disparities in health, not only to deliver aggregate national gains.

The London results also carry a practical lesson about pathway prioritisation. The buildings pathway generates larger exposure reductions in London than surface transport, reversing the national picture and illustrating that locally dominant pollution sources should drive locally tailored policy. A pathway that appears secondary in national results may be more important in a specific city if the relevant emissions sources are concentrated close to where people live and work. This reinforces the value of local exposure data and air quality modelling in helping decision-makers prioritise across transport, heat and industrial decarbonisation in a way that reflects the actual distribution of pollution burdens.



## 6 Wider and emerging co-benefits

### Key takeaways:

- The **quantified results capture only part of the total value** associated with cleaner air.
- **Black carbon emissions fall significantly** under net zero pathways.
- Improved air quality may support wider benefits through **reduced school absence and better educational outcomes**.
- Emerging pressures, including **growing electricity demand from AI-related data centres**, could influence future air quality trajectories.

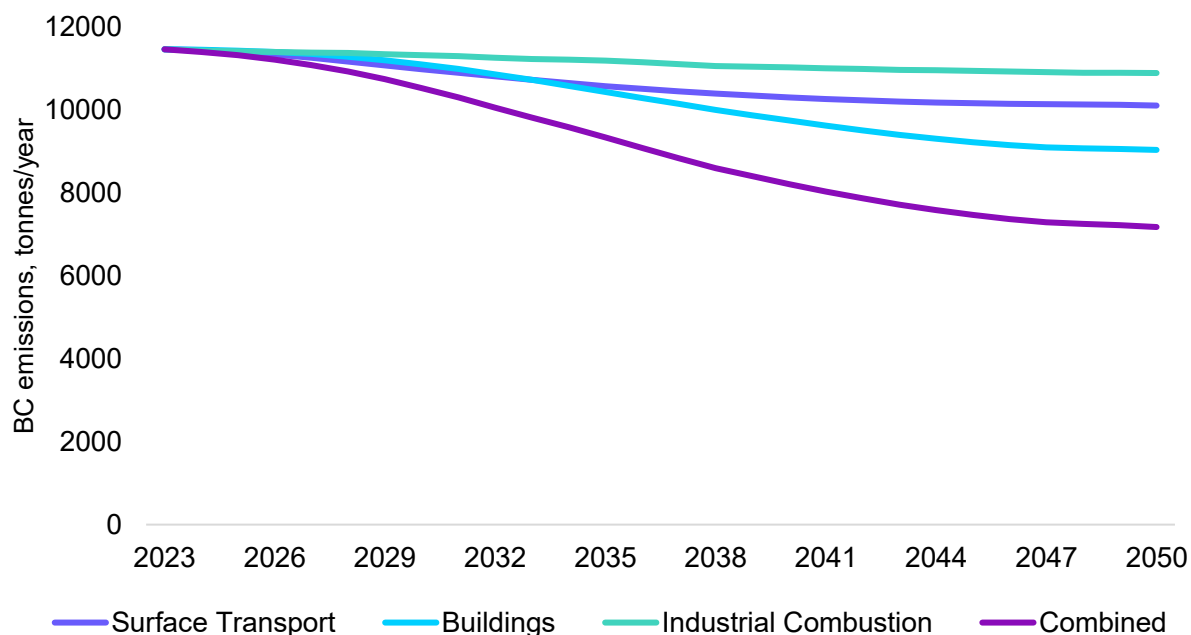
### 6.1 Black carbon and health impacts

Black carbon (BC) is a component of PM<sub>2.5</sub> and one with suspected implications for both health and environmental outcomes<sup>9</sup>. It is not modelled as a separate health or economic pathway in the core analysis because the evidence base for isolating black carbon-specific health effects remains less developed than for PM<sub>2.5</sub> and NO<sub>2</sub>, and because its relationship with PM<sub>2.5</sub> creates a risk of double counting. However, the fall in black carbon emissions across the modelled scenarios has been estimated and is presented in **Figure 11**.

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<sup>9</sup> Department for Environment, Food and Rural Affairs (2025), *Air Pollution in the UK 2024*

**Figure 11:** Change in black carbon emissions across modelled scenarios by sector



**Source:** CBI Economics / WSP (2026)

The buildings pathway reaching net zero produces the largest reduction in black carbon emissions, consistent with the significant fall in PM<sub>2.5</sub> associated with that sector. Surface transport decarbonisation has the second largest impact, followed by industrial combustion. Under the combined scenario, black carbon emissions fall by 19% by 2035 and 37% by 2050, demonstrating that the CCC Balanced Pathway delivers meaningful reductions in pollutants beyond NO<sub>2</sub> and PM<sub>2.5</sub>.



The evidence on black carbon's health effects is still developing. Different emission sources produce different concentrations of black carbon within PM<sub>2.5</sub>, with residential combustion and transport sectors typically generating the highest proportions, in some cases exceeding 90% of total black carbon content<sup>10</sup>. This makes the reductions delivered by the sectors modelled in this study particularly relevant. European research has found associations between black carbon levels and a range of health outcomes across both the short and long term, including respiratory and cardiovascular disease and premature mortality<sup>11,12</sup>. UK-specific evidence, including London-focused research, has identified associations with respiratory mortality and cardiovascular outcomes across most age groups.<sup>13</sup>

Measuring the specific health impact of black carbon presents challenges, partly because within-city concentration gradients can be underestimated when exposure is assessed using single monitoring sites, particularly where there are dominant local sources<sup>14</sup>. There is also ongoing uncertainty about whether the concentration of black carbon within PM<sub>2.5</sub> affects mortality outcomes differently from PM<sub>2.5</sub> as a whole; current evidence suggests broadly equal potency across different PM<sub>2.5</sub> compositions, though many underlying studies carry significant measurement uncertainty<sup>15</sup>.

As the evidence base matures, black carbon-specific research could become increasingly important for policy, particularly in distinguishing the relative health returns from transport emission reductions versus other combustion sources. For now, the modelled reductions in black carbon emissions represent an additional benefit of the CCC Balanced Pathway that is not captured in the headline health and economic figures.

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<sup>10</sup> Klimont et al (2017), [Global anthropogenic emissions of particulate matter including black carbon](#)

<sup>11</sup> Nilsson Sommar et al (2021), [Long-term exposure to particulate air pollution and black carbon in relation to natural and cause-specific mortality: a multicohort study in Sweden](#)

<sup>12</sup> Segersson et al (2017), [Health Impact of PM10, PM2.5 and Black Carbon Exposure Due to Different Source Sectors in Stockholm, Gothenburg and Umea, Sweden](#)

<sup>13</sup> Samoli et al (2016), [Associations of short-term exposure to traffic-related air pollution with cardiovascular and respiratory hospital admissions in London, UK](#)

<sup>14</sup> Segersson et al. (2017), *ibid*

<sup>15</sup> Anenberg et al (2011), [Impacts of global, regional, and sectoral black carbon emission reductions on surface air quality and human mortality](#)

## 6.2 School absence and educational outcomes

School absence is included in the sensitivity analysis rather than the core model, given the less established evidence base relative to other health endpoints. Nevertheless, the estimated impact is substantial. Under the combined scenario, exposure changes are estimated to result in 2.48 million school days gained by 2050.

In the sensitivity productivity estimates, school days gained are valued through the working day gained by a parent or carer. However, the broader consequences of reduced school absence may extend well beyond this. A substantial body of research links school absence to lower educational attainment. Analysis of KS2 and KS4 pupil outcomes in England finds that pupils with higher levels of absence are less likely to achieve expected standards, regardless of absence type<sup>16</sup>. Research using Scottish data suggests that both sickness and truancy-related absences have negative effects on achievement, with effects persisting into post-compulsory education<sup>17</sup>.

Whether reduced school absence translates into improved long-term labour market and earnings outcomes is less clear-cut, with evidence on this link more mixed<sup>18</sup>. Making that connection robustly would require strong assumptions that go beyond what the current evidence supports. Nevertheless, the potential for cleaner air to improve educational outcomes represents a further dimension of benefit that is not captured in the headline figures, and one that warrants closer attention as the evidence base develops.



<sup>16</sup> Department for Education (2025), *The link between attendance and attainment in an assessment year*

<sup>17</sup> Klein et al (2022), *School Absenteeism and Academic Achievement: Does the Reason for Absence Matter?*

<sup>18</sup> Smyth et al (2026), *The long-term outcomes of school absence*

### 6.3 Data centres and emerging air quality risks

The scenarios modelled in this report are aligned with the CCC Balanced Pathway, reflecting current policy trajectories. However, the rapid expansion of artificial intelligence and the data centre infrastructure that supports it introduces an emerging source of energy demand and potential air quality risk that was not modelled in the CCC's Seventh Carbon Budget.

The UK government has made significant commitments to AI investment in recent years, including the designation of five AI Growth Zones<sup>19</sup>. The literature on the environmental and health implications of data centre expansion remains limited<sup>20</sup>, but some important risks are already visible. Parliamentary research has highlighted the use of diesel generators as backup power sources in data centres and noted the potential for associated air quality impacts, without quantifying the health consequences<sup>21</sup>. Government documentation focused on AI infrastructure has concentrated primarily on grid access, energy pricing and planning processes, with less attention given to downstream health implications<sup>22</sup>. The AI Energy Council has been established with a remit to identify low-carbon technologies to meet rising AI energy demand<sup>23</sup>, but the public health implications of that demand have received comparatively little scrutiny.

Additional electricity demand from data centres, and the backup generation required to support it, could put pressure on the energy transition and place some of the health and economic co-benefits identified in this report at risk. This is an area that merits closer monitoring and research as AI-related infrastructure continues to scale.

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<sup>19</sup> Williams and Brawley (2026), *What are data centres and how sustainable are they?*

<sup>20</sup> Gour et al (2026), *Health implications of the rapid rise of data centers in Virginia: an exploratory assessment*

<sup>21</sup> Williams and Brawley (2026), *ibid*

<sup>22</sup> Department for Science, Innovation & Technology (2025), *Delivering AI Growth Zones*

<sup>23</sup> Department for Science, Innovation & Technology and Department for Energy Security & Net Zero (2025), *AI Energy Council: terms of reference*

## 6.4 Implications for future research

The analysis in this report provides a transparent and evidence-based estimate of selected air quality, health and economic co-benefits from CCC-aligned decarbonisation. The wider evidence reviewed in this chapter points to a number of areas where further research would strengthen future appraisal.

Expanding the range of pollutants modelled would be a natural next step. This study focuses on NO<sub>2</sub> and PM<sub>2.5</sub>, reflecting the strongest evidence base, but black carbon, PM<sub>10</sub>, ozone and sulphur dioxide all affect health and economic outcomes. Stronger evidence on the independent effects of these pollutants would support a more complete picture of the benefits of cleaner air.

The geographic scope could also be extended. London is used here as an illustrative case study, but a fuller assessment of spatial variation, comparing cities or examining roadside and neighbourhood-level exposure, would help demonstrate more comprehensively where place-based interventions can deliver the greatest returns.

The health outcome coverage could be broadened further. Air pollution affects a wider range of conditions than those quantified in the core model, including lung cancer, adverse birth outcomes, cognitive decline, mental health and respiratory symptoms. Extending the evidence base in these areas, while carefully managing the risk of double counting with existing endpoints, would support a more complete health impact assessment.

On the economic side, future work could extend the valuation beyond labour market, healthcare and welfare effects. Cleaner air reduces damage to buildings and ecosystems, and wider healthcare costs beyond hospital admissions, including primary care, outpatient treatment and long-term disease management, could materially increase the estimated health system benefits. Improved evidence on restricted-activity days could also allow presenteeism effects to be more robustly quantified.

These research priorities reinforce the conclusion that the results presented in this report should be read as a strong but partial estimate of the co-benefits of cleaner air. The evidence base is already sufficient to demonstrate that decarbonisation delivers substantial health and economic gains. Further research would help capture a wider set of those benefits, reduce uncertainty, and support more systematic inclusion of air quality co-benefits in climate, health and investment appraisal.

# Conclusion

## Clean air is a measurable dividend of net zero

This study shows that cleaner air is more than a welcome co-benefit of decarbonisation: it is a measurable public health and economic gain. We find that achieving the CCC Balanced Pathway reduces greenhouse gas emissions whilst also delivering substantial, measurable and near-term benefits for public health, workforce productivity and the communities that bear the greatest pollution burdens today.

The scale of those benefits is significant. Under the combined scenario, the transition to net zero is projected to avoid nearly 264,000 premature deaths by 2050, generate almost 2.8 million life-years gained, prevent nearly 497,000 hospital admissions, and add over 38 million working days to the economy. These health gains translate into cumulative productivity gains of £153 million by 2030, £2.4 billion by 2040 and £7.7 billion by 2050, with cleaner air generating an estimated £625 million in additional GVA in 2050 alone. This demonstrates that the clean air dividend begins accumulating well within today's policy and investment horizons, while continuing to deliver lasting economic benefits as exposure remains lower.

The benefits are visible through multiple lenses, from improved economic output and reduced healthcare pressures to the wider social value associated with longer, healthier lives. The results focus on selected pollutants, health outcomes and valuation channels where the evidence base is strongest. They should therefore be read as a focused estimate of measurable benefits, not the full value of cleaner air.

The sectoral picture is equally important. Surface transport decarbonisation delivers the largest overall gains, driven by the dominant role of road vehicles in NO<sub>2</sub> emissions. Combustion-related pathways, buildings and industrial, are critical for reducing PM<sub>2.5</sub> exposure, and the analysis shows that treating heat and industrial decarbonisation as central to the clean air agenda rather than peripheral to it is well justified.

Geography adds a further dimension. National averages mask substantial local variation in who gains and by how much, with the largest benefits concentrated in higher-exposure urban areas. London illustrates this vividly. The city captures approximately 17% of UK-wide avoided premature deaths despite representing around 13% of the population. This pattern is not unique to London; it reflects a wider principle that the clean air dividend flows most strongly to the places where pollution is worst, and it has direct implications for how investment and intervention should be targeted. Place-based approaches, informed by local exposure data and local pollution source mixes, can direct resources where the returns are greatest and help address longstanding geographic inequalities in health outcomes.

The wider and emerging impacts reinforce this case further. Black carbon emissions fall by around 37% under the combined scenario, with implications for health that the current evidence base does not yet allow to be fully quantified. School absence reductions may support longer-term educational attainment in ways that extend well beyond the productivity effects captured here. The emerging risks associated with AI-related data centre energy demand serve as a reminder that the trajectory of air quality improvement is not guaranteed. It depends on the energy choices made to power the next phase of technological growth.

Three conclusions follow for policy. First, air quality co-benefits should be integrated more systematically into net zero appraisal frameworks. Health improvements, productivity gains and avoided healthcare pressures form a significant part of the wider value that decarbonisation can create, but are not always fully reflected in standard appraisal frameworks. Better integrating these benefits would give policymakers a more complete picture of the value of net zero.

Second, place matters. The variation in benefits across locations means that locally tailored analysis, drawing on local concentration data, health prevalence rates and economic characteristics, will consistently reveal larger returns than national averages imply.

Third, the evidence base should continue to develop. Expanding the scope of quantified pollutants, health outcomes and valuation channels, including black carbon, educational impacts, ecosystem effects and wider healthcare costs, would move future appraisals closer to the full social value of cleaner air.

Ultimately, this study shows that clean air is not a secondary consequence of net zero. It is one of its most significant, most immediate and most locally felt dividends. Recognising it as such, in appraisal frameworks, in investment decisions and in the public case for decarbonisation, would strengthen the foundation on which the UK's climate transition is built.



# Appendix A: Methodology

## A.1 Air quality scenarios

The first stage of the analysis establishes the decarbonisation scenarios whose emissions changes are modelled. The scenarios focus on surface transport, buildings (residential and non-residential combustion), and industrial combustion, with each pathway aligned to relevant elements of the CCC's Balanced Pathway. These sectors were selected because they are important sources of NO<sub>2</sub> and PM<sub>2.5</sub> emissions with their decarbonisation expected to deliver material air quality benefits. Each individual sector scenario also includes power generation, reflecting its role in enabling wider decarbonisation through electrification. Throughout the report, references to individual sector scenarios should be interpreted as including the associated power generation pathway. A combined scenario is then modelled to capture the aggregate impact across the selected sectors. We provide a brief overview of each sector scenario here but more detail on their pathways aligned with achieving net zero by 2050 can be found in the CCC's Seventh Carbon budget<sup>24</sup>.

WSP developed the emissions scenarios using 2023 UK National Atmospheric Emissions Inventory emissions as the baseline. These gridded emissions data are available at 1km resolution and distinguish between relevant source sectors, including road transport, domestic and commercial combustion, industrial combustion and power generation. Activity assumptions from the CCC's Seventh Carbon Budget (Balanced Pathway) were then used to scale emissions in each sectoral pathway to 2050, allowing the analysis to isolate the air quality effects of selected decarbonisation measures relative to the 2023 baseline.

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<sup>24</sup> Climate Change Committee (2025), [The Seventh Carbon Budget](#)

## Scenario 1: Surface transport + power generation

The first scenario assesses the air quality impacts associated with decarbonisation of surface transport, alongside changes in the power sector. Surface transport is a major source of NO<sub>2</sub> and PM<sub>2.5</sub> emissions, particularly in urban areas and along major road corridors, with NO<sub>2</sub> emissions much higher both for the sector and UK-wide. Decarbonisation in this sector is therefore expected to deliver significant reductions in NO<sub>2</sub>, largely through the transition away from petrol and diesel vehicles towards zero-emission alternatives. Modal shift and vehicle efficiency improvements are also likely to contribute to a decarbonised surface transport sector.

In the modelling, road transport emissions were scaled to reflect projected electric vehicle (EV) uptake, with scaling factors applied to exhaust and non-exhaust emissions. Rail transport was also scaled to reflect electrification assumptions, while power generation emissions were scaled consistently across all scenarios.

## Scenario 2: Buildings + power generation

The second scenario assesses decarbonisation of residential and non-residential combustion, alongside changes in the power sector. This captures emissions associated with heating and other fuel use in homes, commercial buildings and public sector buildings falling due to electrification, heat pumps and energy efficiency improvements.

In the modelling, residential combustion was represented through the domestic combustion component of the emissions inventory, while non-residential combustion drew on relevant commercial and public sector combustion sources. These emissions were scaled using CCC assumptions on the transition to electrified and low-carbon heating.



### **Scenario 3: Industrial combustion + power generation**

The third scenario assesses decarbonisation of industrial combustion, alongside changes in the power sector. Industrial combustion includes fuel use in manufacturing and other industrial processes, where emissions are modelled as falling through electrification and fuel switching in industrial heat processes.

In the modelling, industrial combustion emissions, including associated point sources, were scaled using CCC assumptions on the increasing share of industrial energy demand supplied by electricity.

### **Combined scenario**

The study also models a combined scenario covering surface transport, buildings, industrial combustion and power generation, providing a central estimate of the co-benefits associated with all modelled pathways together. This scenario is modelled separately rather than derived by summing the individual sector results, since each sector scenario already incorporates the power generation pathway and simple addition would therefore triple count those contributions.

## **A.2 Exposure modelling**

WSP modelled changes in NO<sub>2</sub> and PM<sub>2.5</sub> concentrations under each scenario using its RapidAir air quality modelling software. For each pathway, emissions rasters (1 km resolution digital image/map) were produced using the sectoral emissions assumptions described above, and annual average concentrations were modelled for both pollutants across the UK. NO<sub>2</sub> concentration maps were derived from modelled NO<sub>x</sub> concentrations.

The model outputs provide concentration maps for the 2023 baseline and each decarbonisation scenario in 2050. These maps were then aggregated across relevant geographies and combined with population data to estimate population-weighted exposure. Population weighting is important because the health impact of air pollution depends not only on where concentrations change, but on how many people experience those changes. A reduction in pollution in a densely populated area will therefore have a larger health impact than an equivalent concentration reduction in a less populated area.

The resulting population-weighted NO<sub>2</sub> and PM<sub>2.5</sub> concentration estimates form the direct input into the health impact modelling. They allow the analysis to estimate how people's exposure to air pollution changes over time under each pathway, before translating those exposure changes into health and economic impacts.

The modelling should be interpreted with some important scope considerations. It is based on 1 km resolution concentration modelling, which is granular for national analysis but may smooth over highly localised pollution hotspots, particularly close to major roads or industrial sources. For PM<sub>2.5</sub>, the emissions inputs focus on primary domestic emissions and do not fully capture secondary particulate formation or transboundary sources, which can account for a meaningful share of measured PM<sub>2.5</sub> concentrations. As a result, the exposure changes presented here are best understood as the modelled benefits of selected UK sectoral decarbonisation pathways, rather than the full potential change in ambient air quality under economy-wide or international decarbonisation.

### A.3 Health impacts

The health impact assessment translates modelled changes in air pollution exposure into physical health outcomes, following the standard impact pathway approach. This involves taking the exposure changes produced by the air quality modelling and applying established epidemiological evidence to estimate how reductions in pollutant concentrations affect the incidence of mortality, hospital admissions and illness across the population.

The starting point is establishing the baseline health burden – the expected number of deaths, admissions or cases of illness in each year before accounting for any air quality improvement. This is calculated by combining baseline rates for each health outcome, with population projections by age band and year. Baseline rates are held constant throughout the modelling period to avoid making speculative assumptions about future trends in disease incidence.

Exposure changes are then translated into health outcomes using concentration-response functions (CRFs), which capture the established relationship between changes in pollutant exposure and changes in health risk. These functions are drawn from the published epidemiological literature and applied consistently with COMEAP guidance on the quantification of health effects associated with air pollutants.<sup>25</sup> The core model focuses on outcomes where the evidence base is strongest - principally mortality, hospital admissions and selected morbidity endpoints. Outcomes with a less established evidence base are quantified separately and presented in sensitivity analysis rather than the central results, so readers can distinguish between core estimates and wider indicative impacts.

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<sup>25</sup> Committee on the Medical Effects of Air Pollutants (2022), [Recommendations for the Quantification of Health Effects Associated with Air Pollutants](#)

Not all health benefits are felt immediately. Some outcomes, such as hospital admissions and school absence, are treated as same-year effects. Others, including mortality and some chronic disease outcomes, are subject to lag assumptions, meaning that the full benefit of reduced exposure accumulates over several years rather than being realised at once. These lag structures are set out in the [technical annex](#).

A small number of health outcomes are excluded from the core model by design. Lung cancer, while clearly associated with air pollution, is excluded because it is almost always fatal and including it would risk double-counting with the all-cause mortality outcome. Health outcomes associated with pollutants outside the scope of the core modelling, such as black carbon and ozone, are discussed separately in **Section 6**. These exclusions mean the health estimates should be interpreted as selected, evidence-based impacts rather than a complete assessment of all possible health benefits from cleaner air.

## A.4 Economic impacts

The economic valuation translates the physical health impacts estimated into monetary values, demonstrating how cleaner air generates benefits through improved workforce health, reduced healthcare demand and improved wellbeing. These impacts are valued through three distinct channels - productivity, healthcare costs and welfare - each of which answers a different appraisal question. The channels are described separately throughout the report rather than combined into a single figure because they measure conceptually different forms of value, and therefore should not be treated as directly additive.

### Productivity valuation

The productivity model estimates the labour-market benefits of avoided illness and premature mortality, following the Human Capital Approach (HCA) in line with Defra guidance<sup>26</sup>. This approach captures productivity impacts through reduced labour market participation, working time and work-related output. The method applied varies by health endpoint, using the labour-market channel most appropriate to each outcome. For conditions such as asthma, diabetes and ischaemic heart disease (IHD), the model values avoided working days lost. For stroke, a return-to-work framework is applied, distinguishing between those who return to work quickly, those who return later, and those who do not return. For COPD, the model captures both annual work-loss effects and an early retirement channel. For mortality, avoided deaths generate future working-year streams valued at GVA per worker. For dementia, productivity impacts are captured through the effect on informal caregiver work impairment.

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<sup>26</sup> Department for Environment, Food and Rural Affairs (2026), [Air quality appraisal: impact pathways approach](#)

## Healthcare cost valuation

The healthcare cost model estimates avoided NHS resource costs from reduced hospital admissions, valuing avoided cardiovascular and respiratory admissions using unit costs derived from NHS admitted patient care data<sup>27</sup>. The healthcare valuation is intentionally narrow in scope - it focuses on the hospital admission endpoints included in the health model and does not extend to GP appointments, medication, outpatient care, social care or long-term disease management. Healthcare savings should therefore be read as a partial estimate of avoided health system costs rather than a comprehensive accounting of NHS expenditure avoided.

## Welfare valuation

The welfare model estimates the value of improved health and quality of life, following Defra valuation methods and Green Book principles and drawing on Defra's damage costs report<sup>28</sup>. Mortality impacts are valued using the Value of a Life Year (VOLY), applied to modelled life years gained. Hospital admissions are valued using willingness-to-pay values per avoided admission. Other morbidity endpoints are valued using a QALY-based approach, combining avoided cases with assumptions on utility loss, duration and the monetary value of a QALY. Full details of these assumptions are set out in the [technical annex](#).

Welfare valuation allows the model to capture quality-of-life effects not reflected in productivity or healthcare cost savings. However, because welfare values are more sensitive to assumptions around utility losses, durations and monetary unit values, they are interpreted separately from the productivity results and should be read alongside rather than instead of them.

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<sup>27</sup> NHS England (2025) [National Cost Collection for the NHS](#)

<sup>28</sup> WSP (2025) [Air Quality Damage Cost Update 2025](#)

## Appendix B: Sensitivity analysis results

Monetised benefits realised by 2050 by valuation method, using low/central/high CRF estimates for each scenario (all scenarios include power generation)

**Table B1:** Core health endpoints

	Productivity			Healthcare			Welfare		
	Low	Central	High	Low	Central	High	Low	Central	High
<b>Surface Transport</b>	£2,168m	£6,389m	£10,295m	£314m	£595m	£887m	£31bn	£95bn	£155bn
<b>Buildings</b>	£1,776m	£5,269m	£8,513m	£254m	£482m	£718m	£25bn	£78bn	£129bn
<b>Industrial combustion</b>	£1,356m	£4,033m	£6,524m	£199m	£378m	£562m	£20bn	£62bn	£102bn
<b>Combined</b>	£2,615m	£7,696m	£12,389m	£380m	£720m	£1,072m	£37bn	£114bn	£186bn

**Table B2:** Core + sensitivity health endpoints

	Productivity			Healthcare			Welfare		
	Low	Central	High	Low	Central	High	Low	Central	High
<b>Surface Transport</b>	£2,682m	£7,992m	£13,030m	£314m	£595m	£887m	£82bn	£264bn	£460bn
<b>Buildings</b>	£2,204m	£6,629m	£10,846m	£254m	£482m	£718m	£68bn	£218bn	£381bn
<b>Industrial combustion</b>	£1,725m	£5,128m	£8,381m	£199m	£378m	£562m	£53bn	£168bn	£295bn
<b>Combined</b>	£3,180m	£9,558m	£15,589m	£380m	£720m	£1,072m	£100bn	£321bn	£558bn

# Appendix C: Additional air quality modelling outputs

## C.1 Purpose of this appendix

This appendix presents additional air quality modelling outputs produced by WSP to support the findings in **Sections 2, 5 and 6** of the main report. The figures show modelled annual average concentrations and changes in concentrations under the selected CCC-aligned scenarios, alongside supporting emissions trajectories for NO<sub>x</sub>, PM<sub>2.5</sub> and black carbon.

Further detail on the construction of the scenarios, emissions inputs, air quality modelling approach and exposure modelling is provided in the accompanying [technical annex](#).

**Notes on interpretation:** The concentration maps are modelled at 1 km resolution and should be interpreted as national and regional modelling outputs rather than street-level exposure estimates. The PM<sub>2.5</sub> results reflect primary emissions from selected UK sectors and do not fully capture secondary or transboundary particulate matter. Results should therefore be read as the modelled air quality benefits of selected UK sectoral pathways rather than the full potential change in ambient air quality under economy-wide net zero.

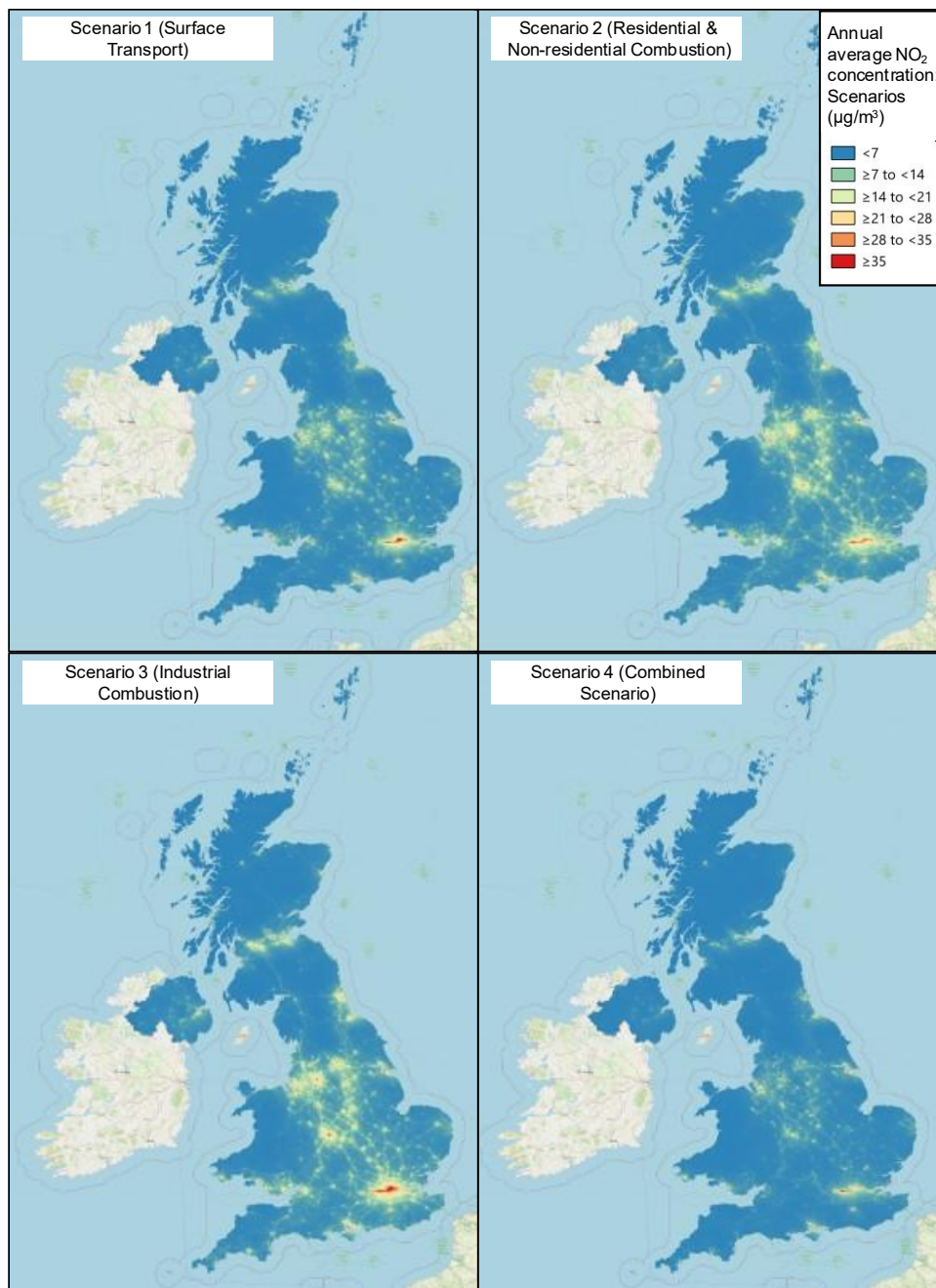


## C.2 UK concentration modelling outputs

### C.2.1 UK NO<sub>2</sub> concentration changes by scenario

The figures below show modelled annual average NO<sub>2</sub> concentrations under each selected scenario, followed by the change in concentration relative to the 2023 baseline. These outputs support the NO<sub>2</sub> exposure results presented in **Section 2.2** of the main report.

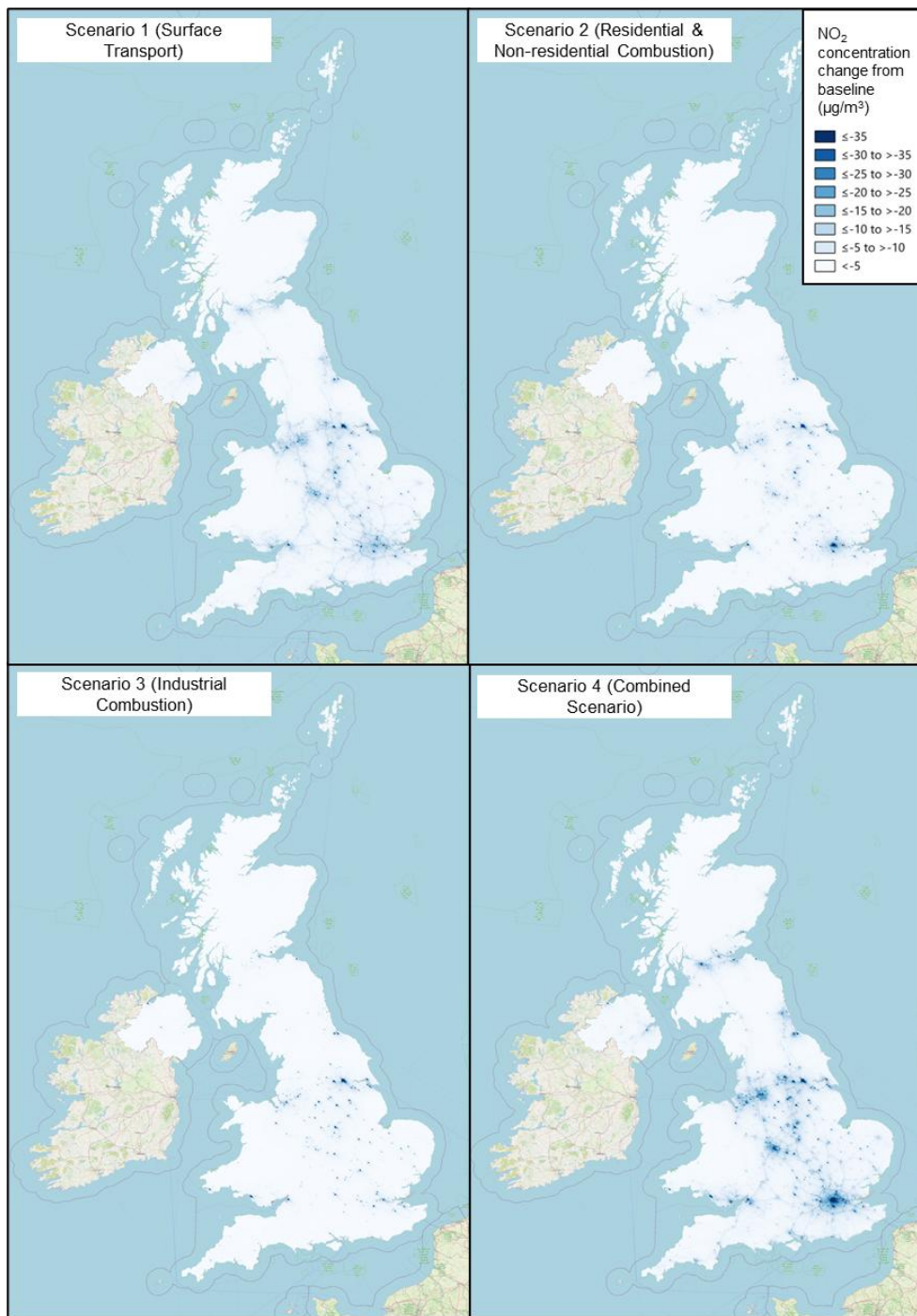
**Figure C1:** Annual average NO<sub>2</sub> concentrations, UK, selected scenarios



Source: WSP modelling (2026)

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**Figure C2:** Change in annual average NO<sub>2</sub> concentrations from baseline, UK, selected scenarios

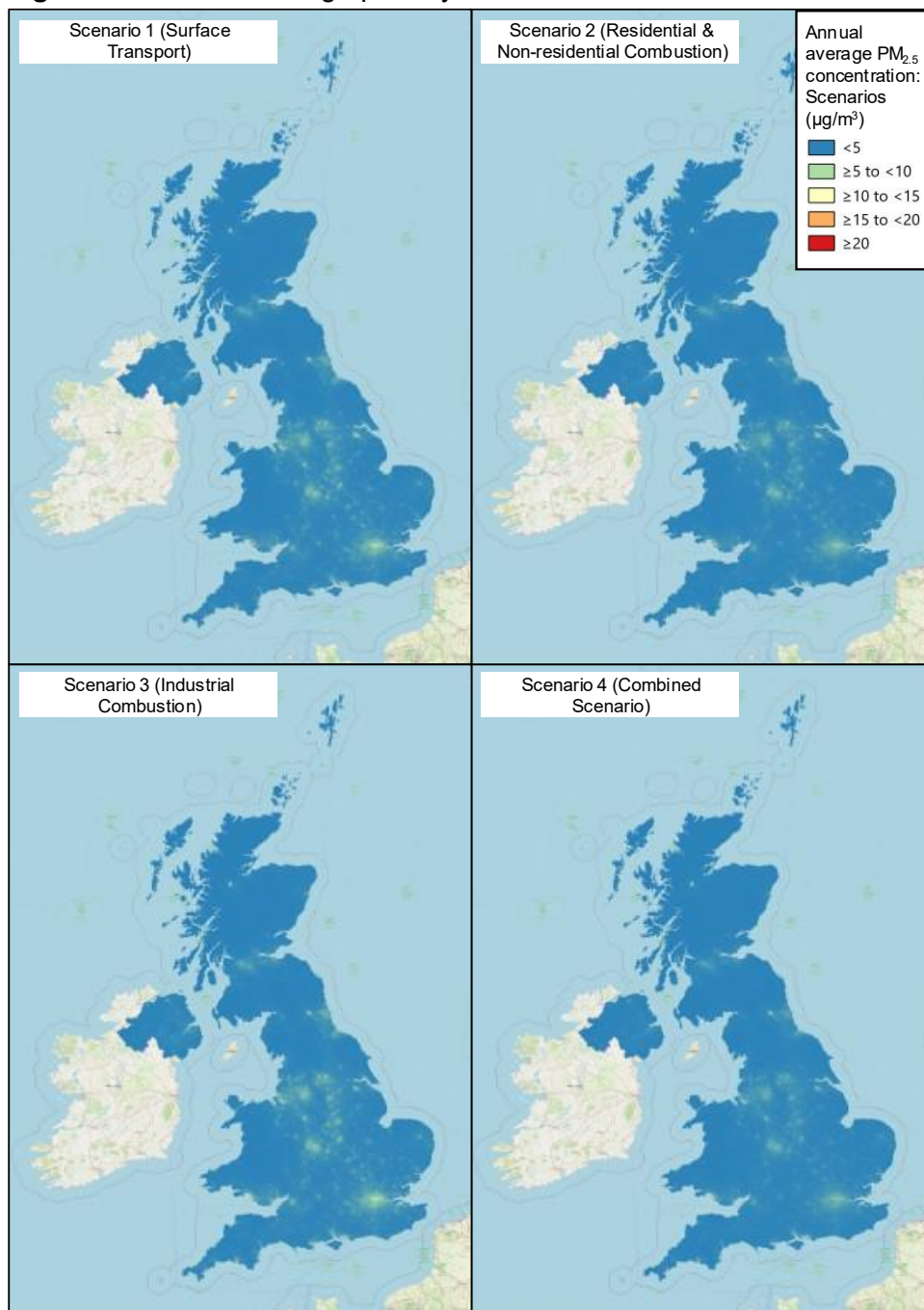


Source: WSP modelling (2026)

## C.2.2 UK primary PM<sub>2.5</sub> concentration changes by scenario

The figures below show modelled annual average PM<sub>2.5</sub> concentrations under each selected scenario, followed by the change in concentration relative to the 2023 baseline. These outputs support the PM<sub>2.5</sub> exposure results presented in **Section 2.3** of the main report.

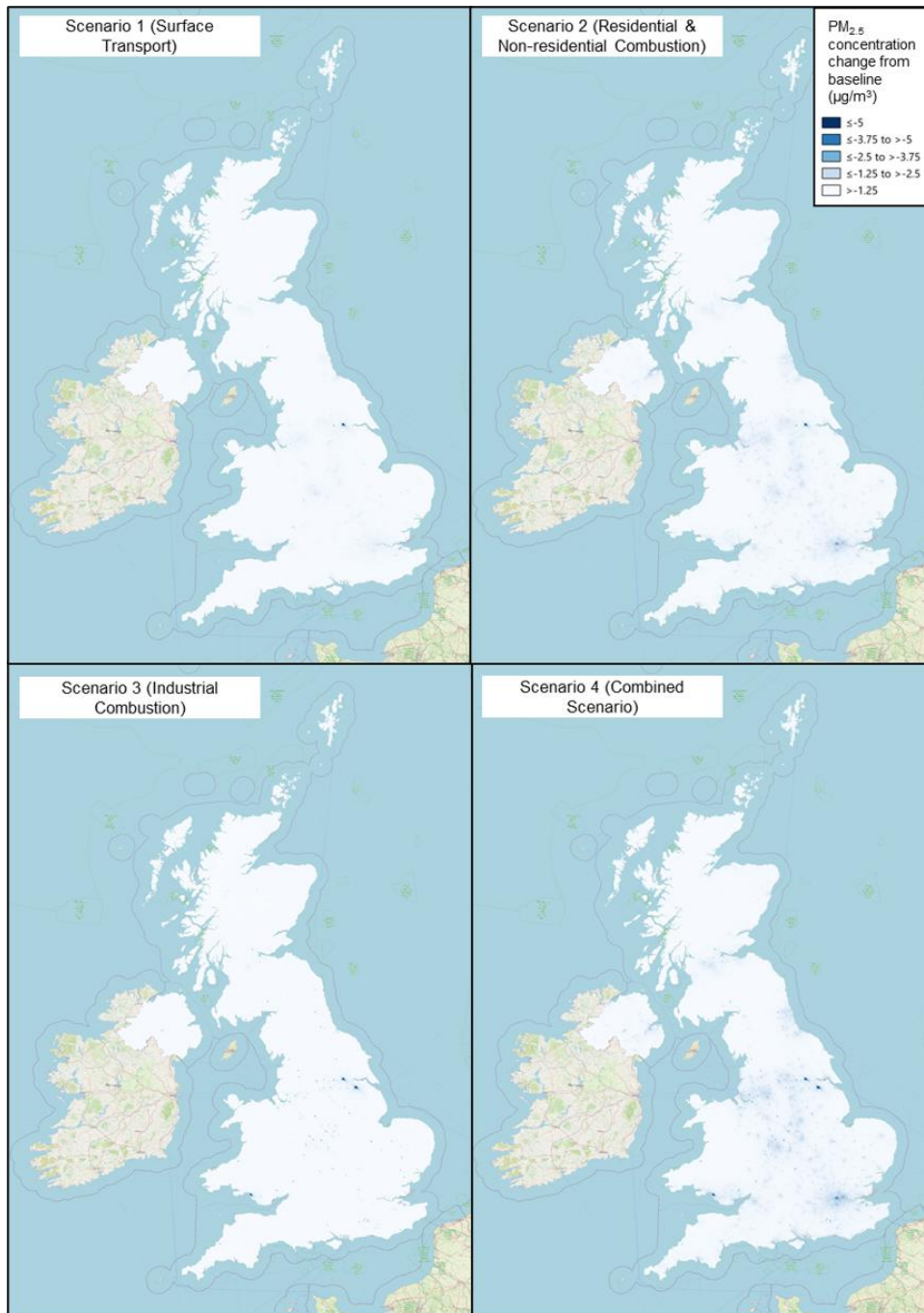
**Figure C3:** Annual average primary PM<sub>2.5</sub> concentrations, UK, selected scenarios



Source: WSP modelling (2026)

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**Figure C4:** Change in annual average PM<sub>2.5</sub> concentrations from baseline, UK, selected scenarios



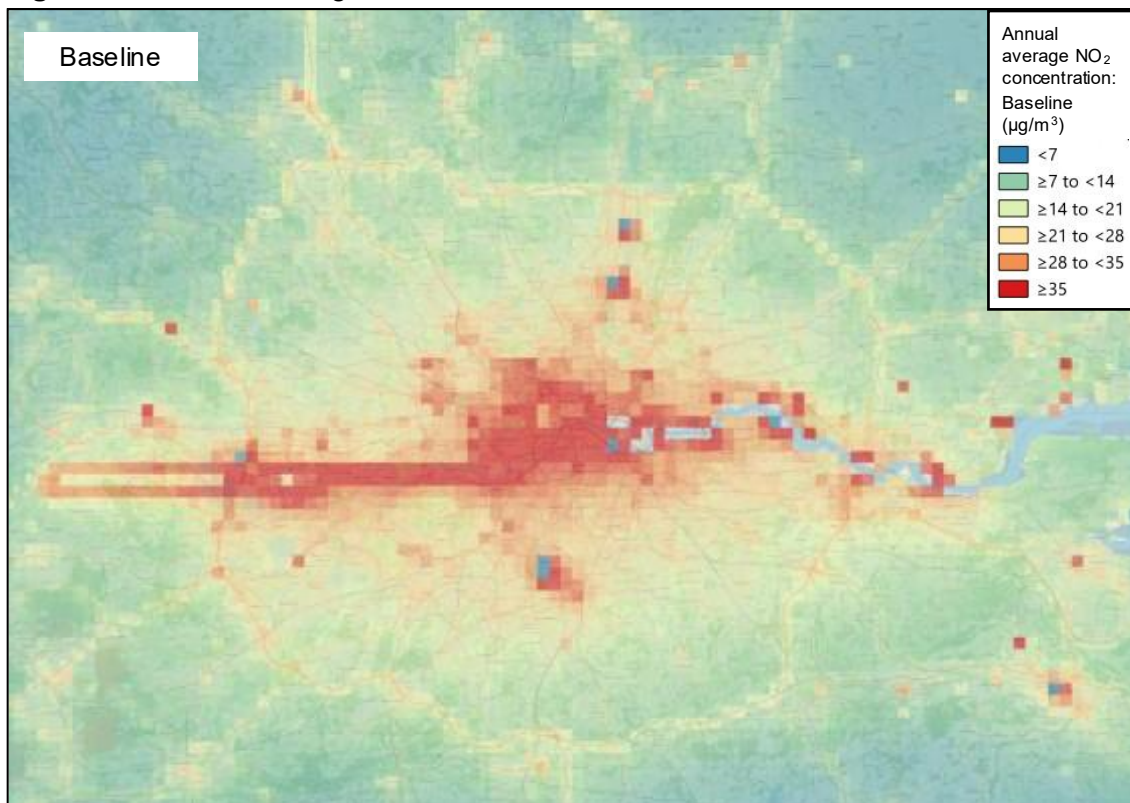
Source: WSP modelling (2026)

## C.3 London concentration modelling outputs

### C.3.1 London baseline concentrations

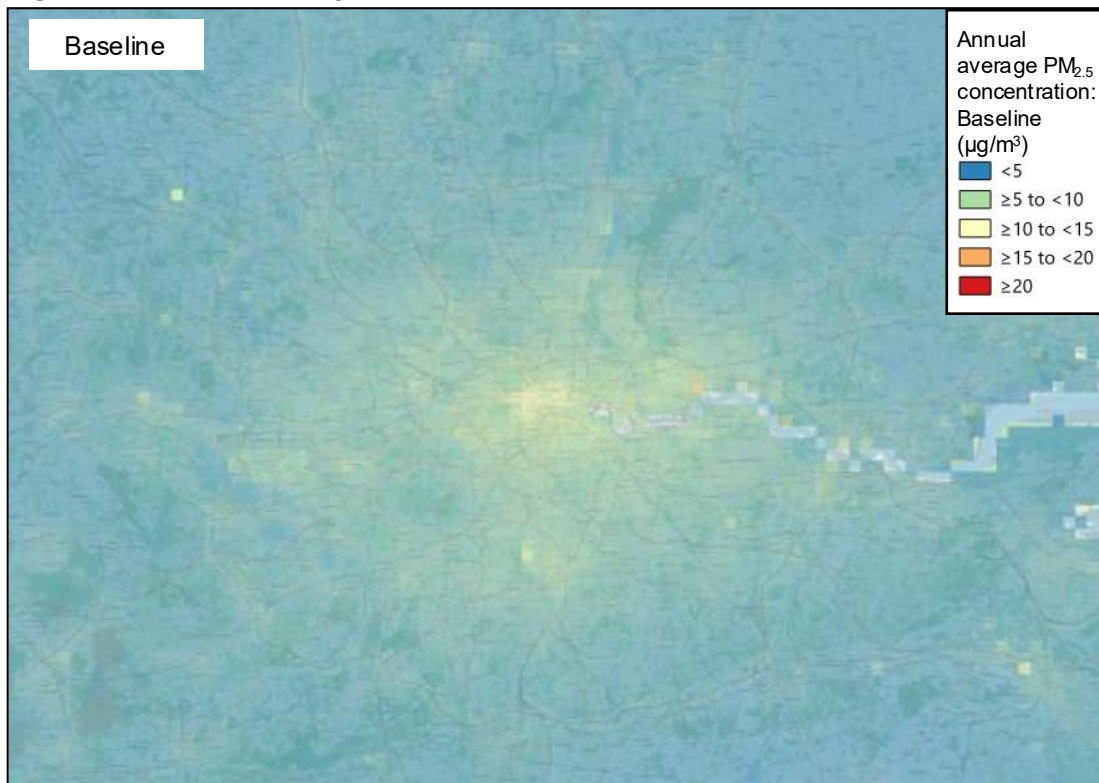
This section presents the modelled 2023 baseline concentrations for NO<sub>2</sub> and PM<sub>2.5</sub> in London. These maps support the London illustrative application in **Section 5** of the main report.

**Figure C5:** Annual average NO<sub>2</sub> concentrations, London, 2023 baseline



**Source:** WSP modelling (2026)

**Figure C6:** Annual average PM<sub>2.5</sub> concentrations, London, 2023 baseline



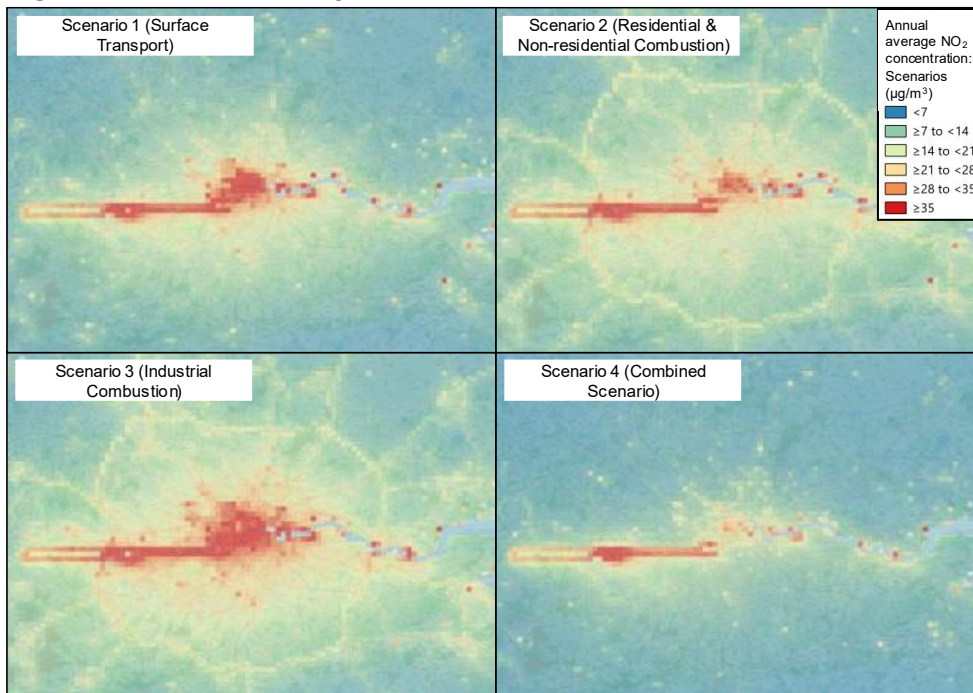
Source: WSP modelling (2026)

### C.3.2 London NO<sub>2</sub> concentration changes by scenario

The figures below show modelled annual average NO<sub>2</sub> concentrations in London under each selected scenario, followed by the change in concentration relative to the 2023 baseline.

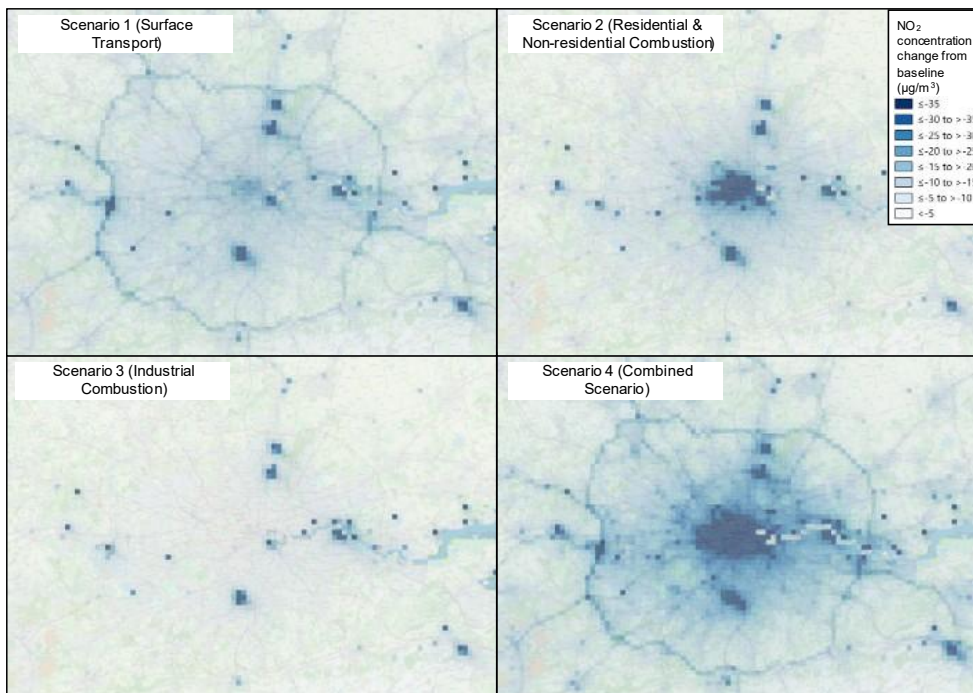


**Figure C7:** Annual average NO<sub>2</sub> concentrations, London, selected scenarios



Source: WSP modelling (2026)

**Figure C8:** Change in annual average NO<sub>2</sub> concentrations from baseline, London, selected scenarios

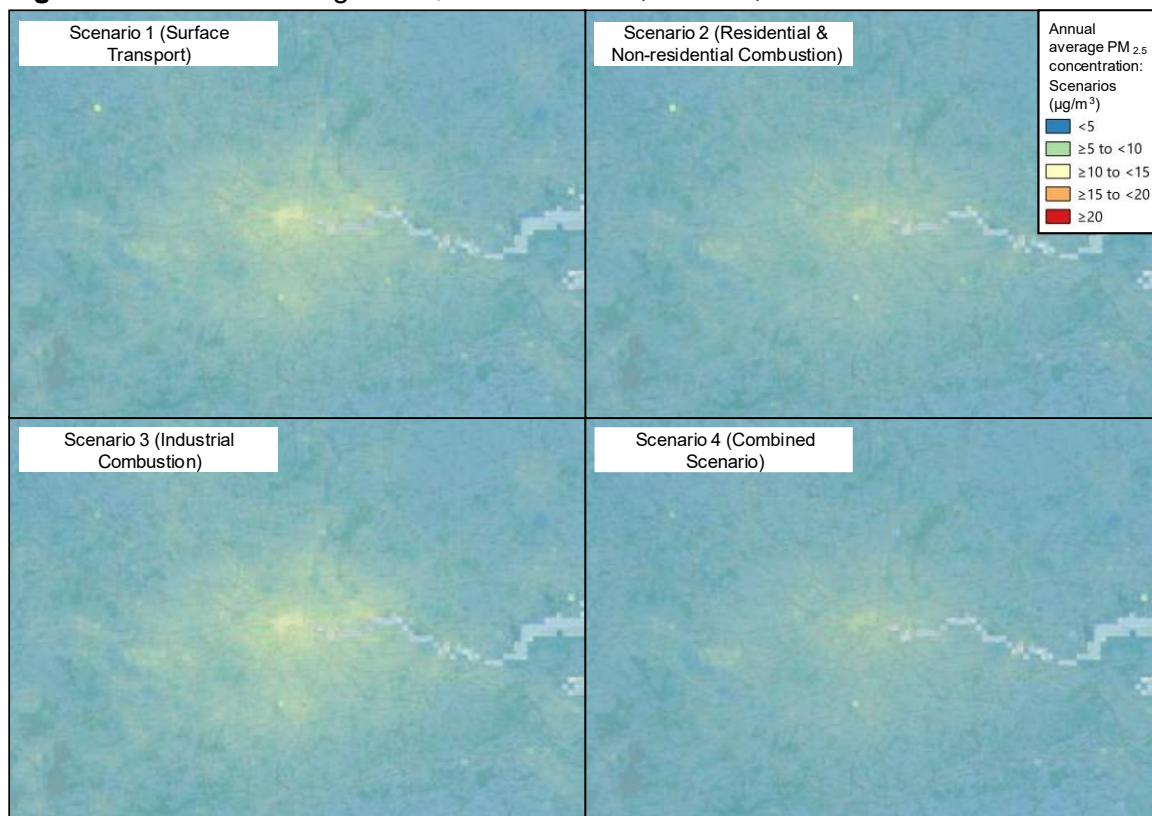


Source: WSP modelling (2026)

### C.3.3 London PM<sub>2.5</sub> concentration changes by scenario

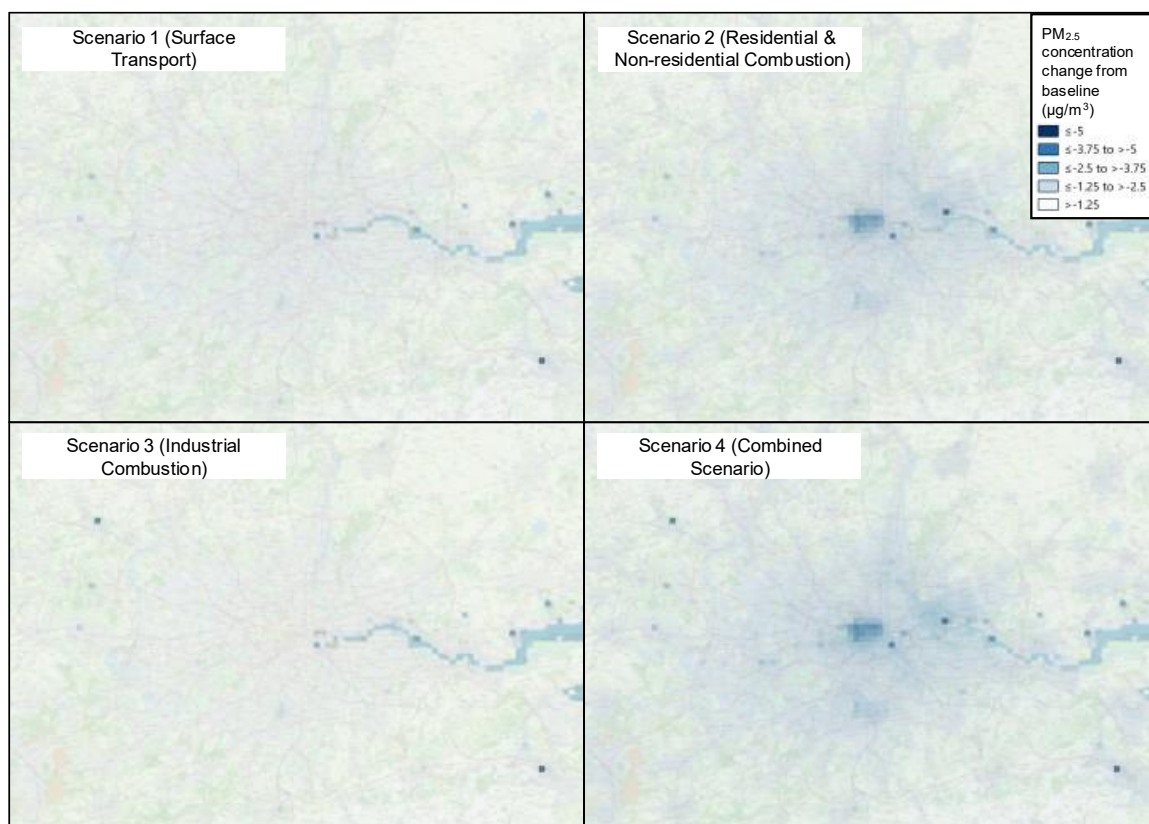
The figures below show modelled annual average PM<sub>2.5</sub> concentrations in London under each selected scenario, followed by the change in concentration relative to the 2023 baseline.

**Figure C9:** Annual average PM<sub>2.5</sub> concentrations, London, selected scenarios



**Source:** WSP modelling (2026)

**Figure C10:** Change in annual average PM<sub>2.5</sub> concentrations from baseline, London, selected scenarios



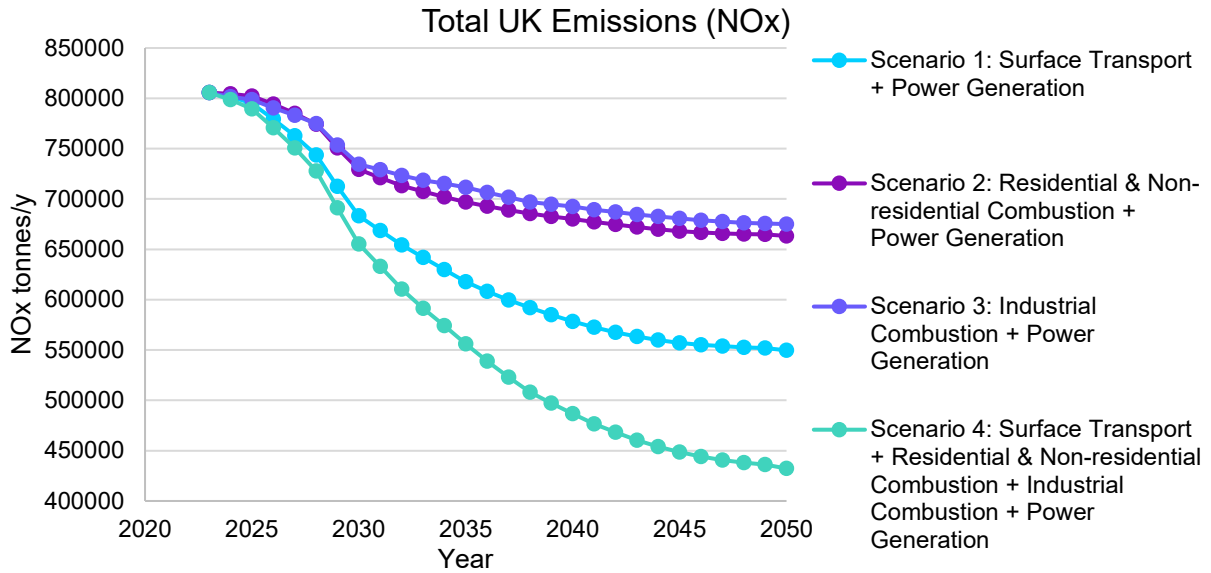
Source: WSP modelling (2026)

## C.4 Emissions trajectories by pollutant

This section presents total UK emissions trajectories for NO<sub>x</sub>, PM<sub>2.5</sub> and black carbon under each selected scenario. These figures support the interpretation of pollutant-specific exposure changes in **Section 2** and the discussion of black carbon in **Section 6**.

### C.4.1 NOx emissions

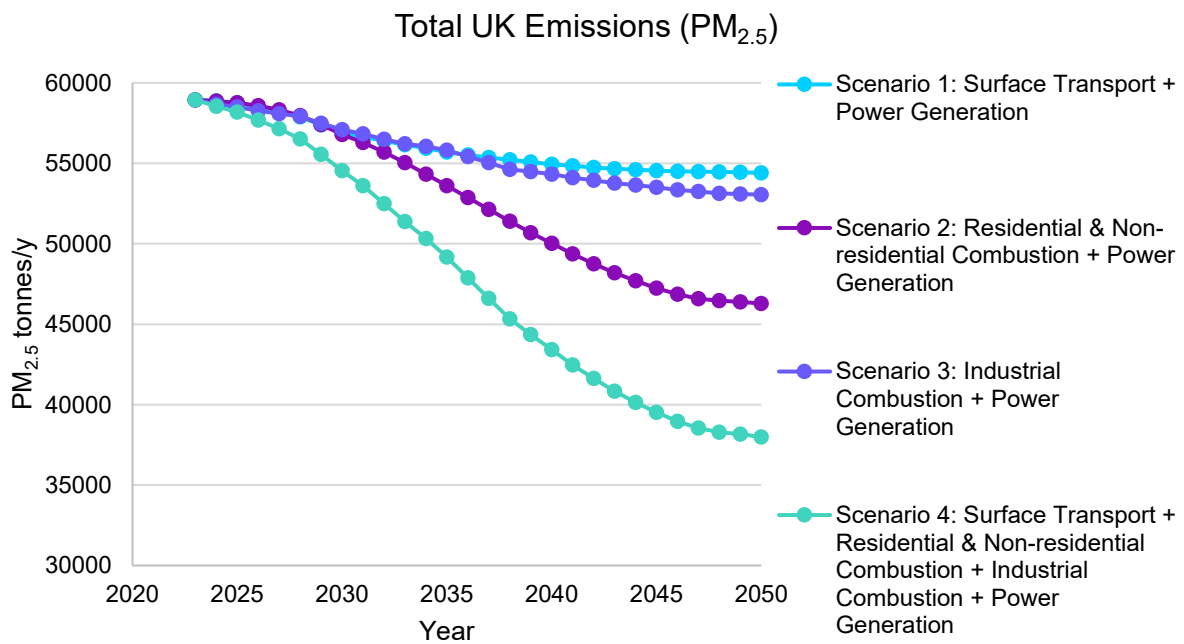
**Figure C11:** Total UK NOx emissions by scenario, 2023 to 2050



Source: WSP modelling (2026)

### C.4.2 PM<sub>2.5</sub> emissions

**Figure C12:** Total UK PM<sub>2.5</sub> emissions by scenario, 2023 to 205

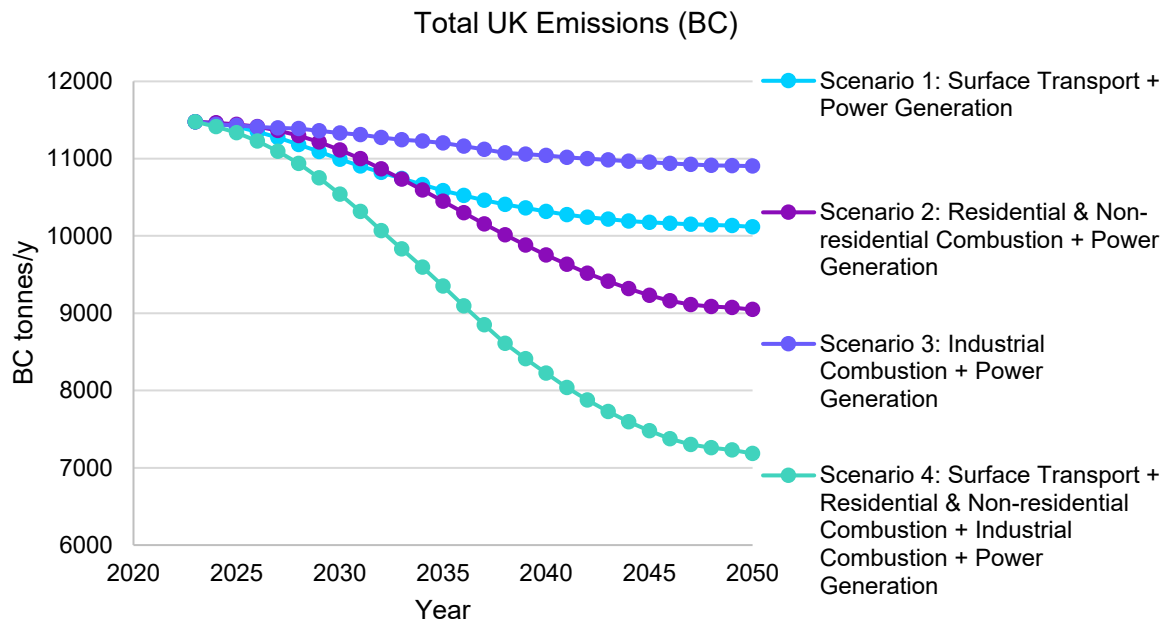


Source: WSP modelling (2026)

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### C.4.3 Black carbon emissions

**Figure C13:** Total UK black carbon emissions by scenario, 2023 to 2050



Source: WSP modelling (2026)



## Appendix D: Additional charts and tables

**Table D1:** Morbidity impacts by 2070 by scenario

Avoided health outcome	Surface Transport	Buildings	Industrial combustion	Combined scenarios
<b>Core health outcomes</b>				
Deaths – NO <sub>2</sub>	279,388	225,964	181,438	335,318
IHD (Coronary heart disease) – PM <sub>2.5</sub>	19,125	20,014	15,317	24,080
Stroke – PM <sub>2.5</sub>	17,275	18,001	13,946	21,542
Respiratory hospital admissions – NO <sub>2</sub>	193,656	156,470	121,477	237,404
Cardiovascular hospital admissions – NO <sub>2</sub>	213,344	171,952	135,229	259,559
<b>Sensitivity health outcomes</b>				
Adult asthma – NO <sub>2</sub>	260,408	213,559	159,804	324,909
Child asthma – NO <sub>2</sub>	126,203	102,397	76,763	156,707
COPD – PM <sub>2.5</sub>	28,029	29,373	22,354	35,413
Dementia – PM <sub>2.5</sub>	120,085	124,517	97,638	148,325
Diabetes – PM <sub>2.5</sub>	31,107	32,730	24,696	39,544
School days – PM <sub>2.5</sub>	1,942,495	2,038,112	1,517,267	2,483,425

**Source:** CBI Economics

**Notes:** Total values are shown for completeness and include benefits accrued by 2070. This only include effects of reduced exposure up to 2050 and not the benefits from sustained lower concentrations levels after 2050. Core outcomes are shown separately from sensitivity outcomes. School days are measured in days; all other morbidity endpoints are measured as cases or admissions.

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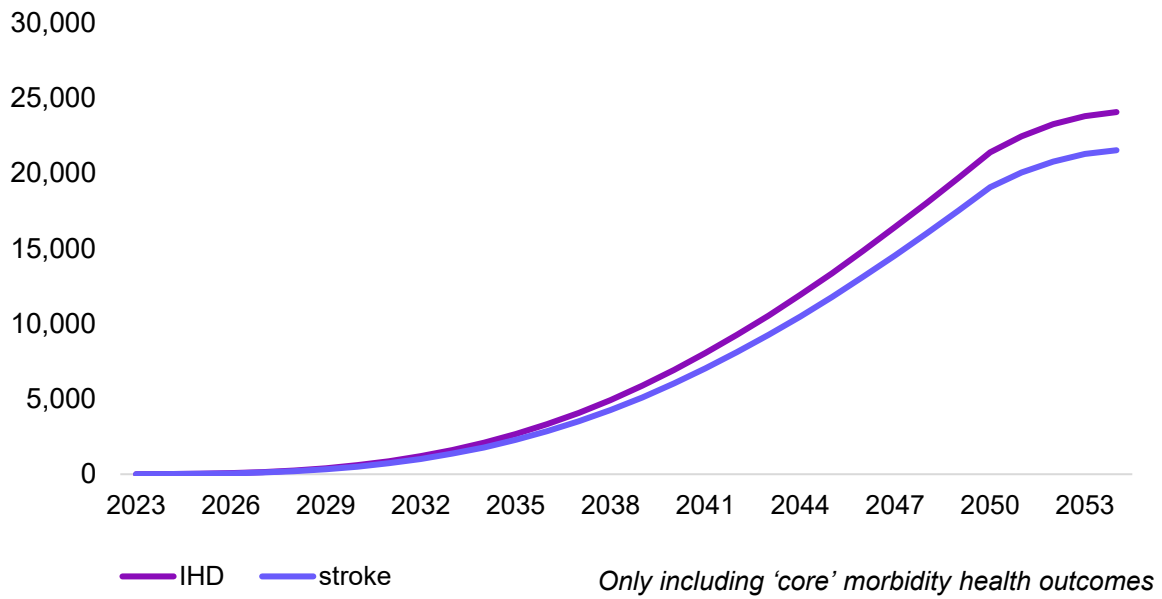
## Economic benefits over time

**Table D2:** Core health outcomes (central estimates)

	Valuation method	2030	2040	2050	2060	2070	2080*
<b>Combined</b>	<b>Productivity</b>	£153m	£2.4bn	£7.7bn	£12.5bn	£14.5bn	<b>£15.1bn</b>
	<b>Healthcare</b>	£65m	£375m	<b>£720m</b>			
	<b>Welfare</b>	£5.0bn	£46.0bn	£114bn	£133bn	<b>£136bn</b>	
<b>Surface Transport</b>	<b>Productivity</b>	£133m	£2.1bn	£6.4bn	£10.2bn	£11.8bn	<b>£12.2bn</b>
	<b>Healthcare</b>	£59m	£321m	<b>£595m</b>			
	<b>Welfare</b>	£4.6bn	£40.4bn	£94.6bn	£110bn	<b>£112bn</b>	
<b>Buildings</b>	<b>Productivity</b>	£91m	£1.7bn	£5.2bn	£8.3bn	£9.6bn	<b>£10.0bn</b>
	<b>Healthcare</b>	£46m	£264m	<b>£482m</b>			
	<b>Welfare</b>	£3.3bn	£33.0bn	£78.2bn	£90.7bn	<b>£92.8bn</b>	
<b>Industrial combustion</b>	<b>Productivity</b>	£94m	£1.4bn	£4.0bn	£6.3bn	£7.3bn	<b>£7.6bn</b>
	<b>Healthcare</b>	£41m	£207m	<b>£377m</b>			
	<b>Welfare</b>	£3.2bn	£26.6bn	£61.6bn	£71.4bn	<b>£73.0bn</b>	

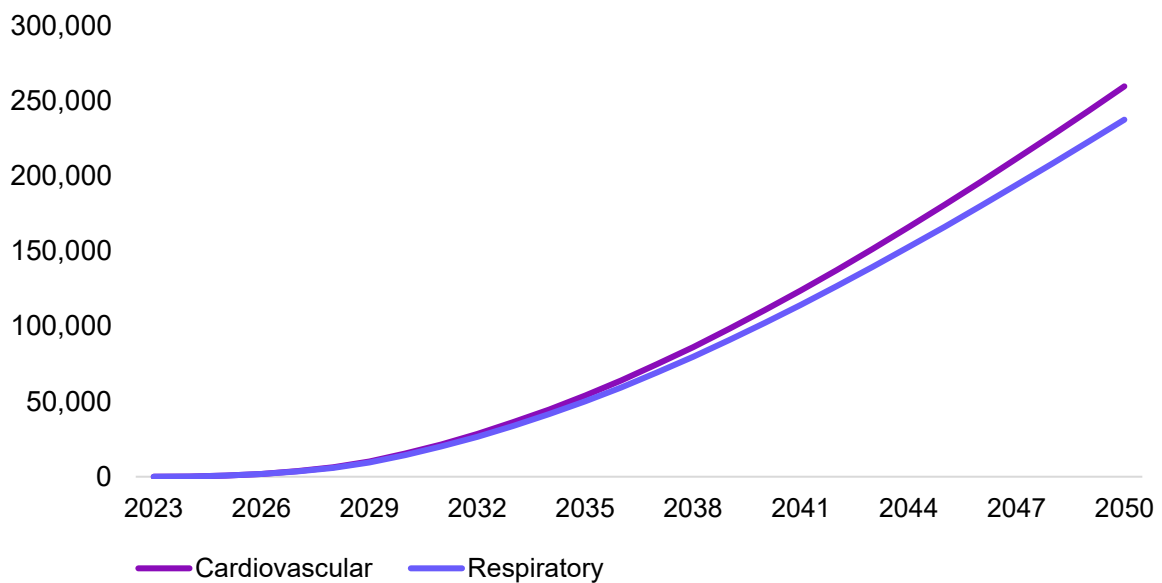
\*Marginal benefits continue to accrue from working years gained until ~2100 but the total values remain at the nearest 2 significant figures.

**Figure D1:** Cumulative avoided cases by morbidity health outcome



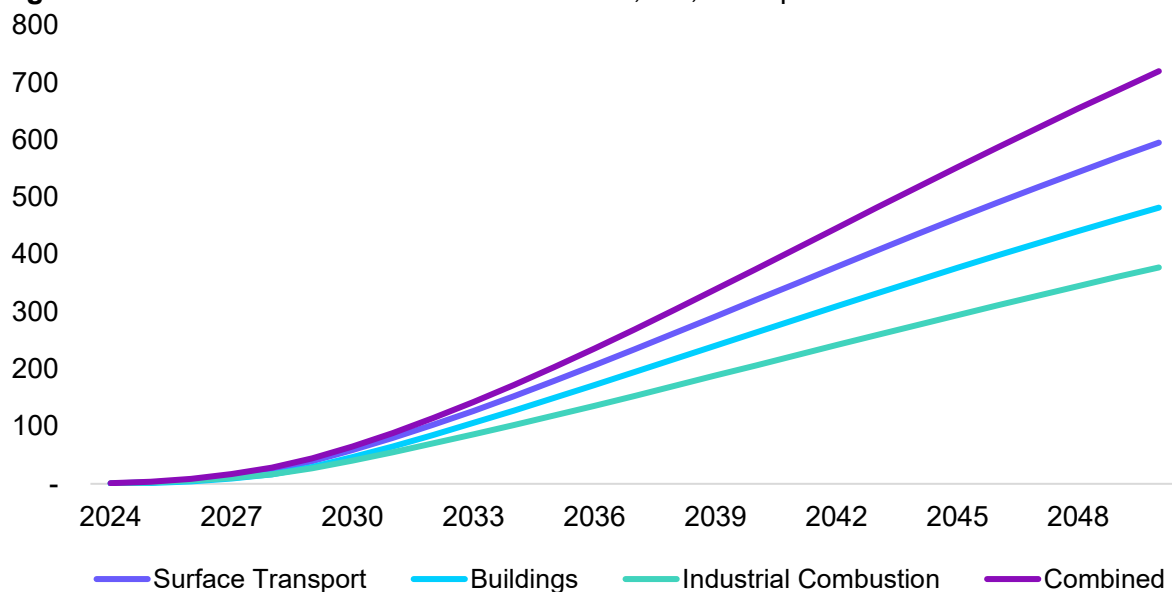
Source: CBI Economics modelling (2026)

**Figure D2:** Cumulative avoided hospital admissions



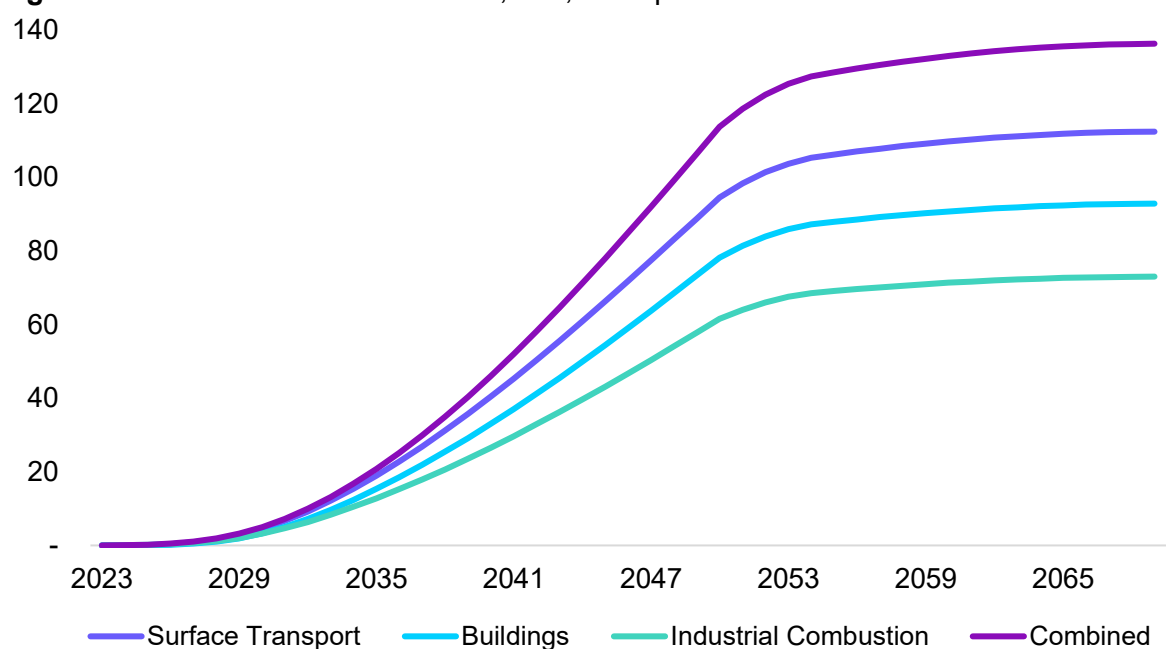
Source: CBI Economics modelling (2026)

**Figure D3:** Cumulative healthcare costs avoided, £m, 2023 prices



Source: CBI Economics (2026)

**Figure D4:** Cumulative welfare benefit, £bn, 2023 prices



Source: CBI Economics (2026)

## Appendix E: Literature review and findings comparison

A growing body of literature shows that improving air quality can deliver significant health and economic co-benefits. The core logic is consistent across studies with reduced exposure to pollutants such as PM<sub>2.5</sub> and NO<sub>2</sub>, lowering mortality and morbidity risks leading to positive economic co-benefits. Defra's Impact Pathways Approach<sup>29</sup> provides the standard UK appraisal framework for this type of analysis, moving from emissions changes to concentration changes, to health impacts and monetary valuation. This section explains some of those key differences and how our findings can be interpreted alongside those in the established literature.

The CCC's Seventh Carbon Budget<sup>30</sup> explicitly recognises air quality as one of the major co-benefits of the Balanced Pathway. Its wider co-benefits analysis identifies improved outdoor air quality as the largest quantifiable co-impact of the pathway, valuing the health-related benefit related to improvements in outdoor air quality at £2.7 billion per year in 2040. The CCC uses UK air quality damage costs developed by WSP for Defra, capturing a wider set of pathways including chronic mortality, acute and chronic morbidity, ecosystem services, infrastructure damage and economic productivity<sup>31</sup>. This provides an important benchmark for this study, but the results are not directly comparable. The CCC analysis uses an emissions-based damage cost approach, while this study uses sector-specific air quality concentration modelling to estimate changes in population-weighted exposure before translating these into productivity, healthcare and welfare impacts through a bespoke model. This allows the analysis to trace the pathway from selected decarbonisation measures to changes in the air people breathe, and then to health and economic outcomes. As a result, the study provides a more granular assessment of selected sector pathways, rather than a like-for-like update of the CCC's aggregate co-benefits estimate.

Recent academic work also supports the importance of quantifying air quality co-benefits from net zero pathways. Walton et al. (2025)<sup>32</sup> compare business-as-usual UK policy with Net Zero scenarios from the CCC, using population-weighted concentrations, concentration-response functions and economic valuation. Their study estimates 4.9 million life-years gained during the longer time horizon of 2019-2154. Despite some difference in methodological choices in accounting for population growth, baseline rates and productivity valuation method by health outcome, the magnitude of our findings is broadly similar.

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<sup>29</sup> Department for Environment, Food and Rural Affairs (2026), [Air quality appraisal: impact pathways approach](#)

<sup>30</sup> Climate Change Committee (2025), [The Seventh Carbon Budget](#)

<sup>31</sup> Applying Defra's damage costs estimates to the emissions reductions by 2050 in our study results in an economic benefit of £3.8 billion in the combined scenario. This is £2.9bn, £2.7bn and £1.9bn in scenarios 1, 2 and 3 respectively (2023 prices).

<sup>32</sup> Walton et al (2025) [Health and associated economic benefits of reduced air pollution and increased physical activity from climate change policies in the UK](#)

The Imperial College / Clean Air Fund “Pathway to WHO” study<sup>33</sup> provides further related estimates with 98,000 life years gained per year from 2018-30 if concentrations were aligned with WHO targets. The change in life years lost, by 2134, is estimated to be around 11 million when they compare life years lost associated with NO<sub>2</sub> across their scenarios. Considering, the narrower scope and shorter time frame of our study, our combined scenario finding of 3.5 million life years gained associated with the improved NO<sub>2</sub> concentration levels is again broadly similar.

There are several reasons why the findings in this report may differ from other studies. First, this study does not model achievement of the full CCC Balanced Pathway across the whole economy. It focuses on selected sectors — surface transport, residential and non-residential combustion, industrial combustion and power generation — so the quantified pollutant reductions and health benefits are expected to be lower than studies capturing a broader transition. Second, the model estimates how concentration changes and health benefits build year by year and compare to a baseline pathway where each year pollutant concentrations remain at 2023 levels. This enables a consideration of how these effects build over time which may differ from other studies. Furthermore, the assumption of a baseline pathway compared to a business-as-usual scenario where concentrations fall in the baseline may lead to our results being larger.

Third, this study uses population-weighted exposure changes and focuses on primary NO<sub>x</sub> and PM<sub>2.5</sub> emissions from selected UK sources. This improves alignment between exposure changes and where people live, but it also means some wider pollutant pathways are outside the central modelling. In particular, secondary PM<sub>2.5</sub> formation, transboundary pollution, indoor air quality, PM<sub>10</sub>, ozone, sulphur dioxide and black carbon-specific effects are not fully quantified. Studies using broader damage-cost methods or full atmospheric modelling may therefore capture a larger set of effects.

Finally, valuation methods differ across the literature. Some studies use aggregate damage costs, which bundle together multiple health, environmental and economic pathways. This study separates productivity, healthcare and welfare values to avoid presenting conceptually different benefits as a single economic measure. The headline productivity estimate is therefore narrower than a full social-value estimate, while the welfare valuation provides a broader but more assumption-sensitive lens.

Overall, the literature suggests that the direction of effect is well established: reducing combustion-related emissions improves air quality and delivers health and economic benefits. Differences in the scale of results should be interpreted in light of modelling scope, pollutant coverage, timing assumptions, health endpoints and valuation methods. On this basis, the results in this report should be viewed as a robust and transparent estimate of the benefits of cleaner air, rather than as a contradiction of wider studies that model broader policy pathways, different time periods or an alternative set of impact channels.

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<sup>33</sup> Dajnak et al (2022) [Pathway to WHO: achieving clean air in the UK](#)

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