May 2026

LONDON ATMOSPHERIC EMISSIONS INVENTORY 2022 UPDATE

Executive Summary

The London Atmospheric Emissions Inventory (LAEI) is a London-based system that estimates and reports on emissions of various pollutants from different sources within Greater London. This inventory helps in understanding the impact of human activities on the environment and in developing policies to reduce harmful emissions, as well as monitoring the trends in emissions over time.

The LAEI 2022[1] provides an update to the previous LAEI 2019 and a new baseline for 2022. This document provides an overview of the LAEI 2022 output results along with the trend seen from previous LAEI updates and previously published future projections including:

- Changes in nitrogen oxides (NO_x) and particulate matter (PM_{10} and $PM_{2.5}$) emissions over time
- Emissions by pollutant and source, split by Zone (Central, Inner, Outer London and Non-GLA), by borough, and LAEI grid square, including revisions to construction sources, industrial processes, and domestic and commercial cooking emissions made in May 2026 as highlighted in the "Emissions Update (May 2026)" section on page 2.
- Maps of annual mean concentrations for nitrogen dioxide (NO_2), PM_{10} and $PM_{2.5}$
- Analysis of the proportion of London's major roads, and the Transport for London Road Network (TLRN - the London "Red Routes") meeting air quality targets
- The number of Londoners, and the number of schools, hospitals and care homes meeting air quality targets for NO_2 and $PM_{2.5}$

Please note, future projects have not been fully revised as part of this update, as discussed in the Emissions Methodology.

All statistics given in this document are for the Greater London area. As per the London Government Act 1963[2], the area comprising the London boroughs, the City and the Temples shall constitute an administrative area to be known as Greater London.

Given the increasing body of evidence of the health impacts of air pollution, even at levels previously considered to be low, the World Health Organization (WHO) updated their health-based guidelines for air quality in 2021, the first update since 2005. The new air quality guidelines reflect the best available health evidence and WHO's recommendations continue to be recognised globally as the targets that should be met to protect public health. The recommended level for annual mean NO_2 has been revised from 40 µg/m^3 in the 2005 guidelines to 10 µg/m^3 in the 2021 guidelines. Similarly, for $PM_{2.5}$ the 2005 guideline was 10 µg/m^3, in the 2021 update this was revised to 5 µg/m^3.

[1] 2022 data is the most up to date available.
[2] https://www.legislation.gov.uk/ukpga/1963/33

Table 1: Recommended WHO Air Quality Guidelines in 2005 and in 2021

Pollutant	Averaging Time	2005 Guideline	2021 Guideline
NO_2	Annual	40	10
PM_{10}	Annual	20	15
$PM_{2.5}$	Annual	10	5

The LAEI 2022 concentration maps and exposure data enable us to track our progress towards meeting these new WHO air quality guidelines for NO_2 and $PM_{2.5}$.

Recognising that many places throughout the world are not yet close to achieving the latest guidelines, the WHO also introduced a series of "interim targets" designed to be used as incremental steps towards meeting the air quality guidelines. While this LAEI release does not include any new forecasts, the previously published LAEI included concentrations forecasts which showed that meeting the interim targets is possible within the timeframe of the dataset. In the London Environment Strategy, the Mayor committed to achieving annual mean concentrations of 10 µg/m^3 of $PM_{2.5}$ by 2030, a full decade before the new UK legal limits. The Mayor has commissioned a scientific and technical evaluation of what action would enable London to achieve its existing target of 10 µg/m^3 annual average $PM_{2.5}$ by 2030, and to reach full compliance with the WHO Guidelines.

The relationship between different clean air targets is described in more detail in the main section of this summary.

Emissions Update (May 2026)

Some discrepancies were identified in the LAEI 2022 data which was published in August 2025 and December 2025. As a result, revisions were made to the emission sources in May 2026. More information about these revisions is outlined below:

- **Construction Sources**
    - Islington: construction NRMM emissions (NO_x and PM) for 2022 have been reverted to 2019 emissions due to incorrect activity data, which led to unusually elevated emissions estimates;
    - Hackney: construction dust emissions (PM) for 2022 have been reverted to 2019 emissions due to incorrect activity data;
    - Westminster: construction dust emissions (PM) for 2022 have been scaled down using a scaling factor of 0.151, following a review of incorrect construction site footprints used to estimate emissions;
    - These issues are linked to issues in the underlying construction activity data from the Planning London Data Hub that is used to estimate total emissions and distribute them spatially across London

- **Industrial Processes – Part A1**

    - Part A1 emissions for all pollutants have been revised for a number of boroughs:
        - Bexley, Newham, Barking and Dagenham, Tower Hamlets: missing sources in Environment Agency's Pollution Inventory (EA-PI) 2022 were added back using the National Atmospheric Emissions Inventory (NAEI) estimates instead;
        - Sutton/Merton: Source wrongly allocated to Merton (Viridor waste management, Beddington Lane) was removed and added back to the correct borough (Sutton). This was due to incorrect Eastings/Northings coordinates used to project that source on to the LAEI grid;
        - Brent, Enfield: Duplicated sources in LAEI grids near the North/South Circular Road have been removed, resulting in small reductions in emissions.

- **Domestic and Commercial Cooking (not affecting 2022 emissions)**

    - All boroughs: previous baselines 2016, 2019 and forecast 2025, 2030 emissions amended to reflect the different spatial distribution between domestic (based on house distribution) and commercial (based on commercial premises distribution) cooking emissions, which has been used to spatially distribute total cooking emissions across London in the baseline 2022. Currently published emissions for other years assumed 50/50% split between those, which is incorrect. The total cooking emissions across LAEI is still split 50/50% between commercial vs domestic cooking, but the spatial distribution being different, the totals by borough / LAEI grid have changed. The 2022 emissions remain as published previously.

Key findings are:

The overall findings of this data set show continued progress in the reduction in pollution emissions across London since 2016. Despite positive progress for NOx and $PM_{2.5}$, all pollutants still require further attention and additional resource, specifically PM_{10}.

Emissions

- A sustained and substantial reduction in total emissions has been observed since the introduction of Mayoral air quality policies in 2016, with the most pronounced declines seen in road transport emissions, where NO_x emissions have reduced by over half (51 per cent) by 2022.
- Total NO_x emissions in Greater London fell by 21 per cent between 2019 and 2022, building on the 19 per cent reduction already achieved between 2016 and 2019. Further reductions of 15 per cent by 2025 and 31 per cent by 2030 (relative to 2022 levels) are forecast.
- NO_x emissions from road transport in Greater London fell by 28 per cent between 2019 and 2022, building on the 31 per cent reduction observed between 2016 and 2019. Road transport NO_x emissions are expected to reduce by a further 39 per cent across London in 2025 and 69 per cent by 2030, compared to 2022. This is primarily influenced by strong Mayoral policies specifically targeting vehicle emissions, such as the Ultra Low Emission Zone (ULEZ).
- Total $PM_{2.5}$ emissions reduced by 8 per cent in Greater London between 2019 and 2022 and are forecast to reduce further by 1 per cent by 2025, and 9 per cent by 2030, from 2022 levels.
- Total PM_{10} emissions reduced by 10 per cent in Greater London between 2019 and 2022. From 2022 levels, total PM_{10} emissions are forecast to fall by 2 per cent by 2030.

Concentrations

- For NO_2, the LAEI 2022 data shows that annual mean concentrations across Greater London in 2022 were approximately 21 per cent lower than in 2019. This is a substantial improvement and largely attributed to measures like the ULEZ and its expansion to inner London and cleaner vehicle technologies.
- 50% of Londoners live in areas meeting the WHO interim annual average target of 20 µg/m³ for NO_2. However, work still needs to be done for London to meet the stricter WHO guideline of 10 µg/m³, highlighting that further action is needed to achieve optimal health standards.
- PM_{10} annual averages in 2022 were approximately 7 per cent lower than in 2019, indicating gradual improvement but less pronounced than NO_2 reductions.
- Outer London largely meets the PM_{10} WHO annual guideline of 15 µg/m³, while central London areas remain above this threshold.
- $PM_{2.5}$ annual averages in 2022 are about 15 per cent lower than in 2019, showing strong improvement.
- Most Londoners live in areas meeting the WHO interim annual target of 10 µg/m³ for $PM_{2.5}$, except central London, which remains above this level. However, more work is needed for London to meet the stricter WHO guideline of 5 µg/m³.
- In 2022, all London educational establishments still exceeded the WHO NO_2 guideline of 10 µg/m³, but compliance with interim targets improved, with 69 per cent of schools above 20 µg/m³ and 1.6 per cent above 30 µg/m³. All met the UK legal limit of 40 µg/m³.

The substantial reductions in pollution emissions and concentrations seen are due to a number of different factors including the Mayor's work to improve air quality with schemes such as the ULEZ and its expansion to inner London; the London-wide Low Emission Zone (LEZ) for heavy vehicles; the Non Road Mobile Machinery Low Emission Zone; planning policies such as the Air Quality Positive[3] and Neutral policies[4]; progressive taxi and PHV emissions-based licencing schemes and support for electrification including installation of electric vehicle charge points. Local action by boroughs has also brought improvements to pollution hotspots. Such action has accelerated the reduction in emissions above and beyond that of the natural churn of the vehicle fleet which has also helped reduce emissions and concentrations.

[3] https://www.london.gov.uk/programmes-strategies/planning/implementing-london-plan/london-plan-guidance/air-quality-positive-aqp-guidance
[4] https://www.london.gov.uk/programmes-strategies/planning/implementing-london-plan/london-plan-guidance/air-quality-neutral-aqn-guidance

Introduction

The LAEI is produced by Transport for London (TfL) and the Greater London Authority (GLA) with input from project partners at Imperial College London, Aether, Ricardo, Heathrow Airport and the Port of London Authority.

The 2022 LAEI emissions data was published on 13 August 2025. It provides an update to the previous LAEI 2019 and a new baseline for 2022. The December 2025 update included a slightly revised emissions dataset[5], and added modelled air pollutant concentrations and exposure data to the dataset. The May 2026 update includes additional changes in emissions from the construction and industrial processes sectors, as detailed in section "Emissions Update (May 2026)" further below.

The new base year is 2022 and includes the impacts associated with the operation of the central ULEZ, the ULEZ expansion to the North/South Circular Road which took place in October 2021 and the impacts due to the introduction of tougher standards for the London-wide LEZ in March 2021. It does not include the impacts associated with the London-wide ULEZ expansion which launched in August 2023. The LAEI 2022 is for the base year only and does not include new future projections.

The data from the LAEI is publicly available on the London Data Store and is used by the GLA and London boroughs as an evidence base for air quality policy work, as well as for assessing change over time and formal reporting.

The LAEI 2022 data set includes:

- Emissions trends
- Emissions by pollutant and source, split by London Zone by borough and grid square
- Concentration maps for 2022, for nitrogen dioxide (NO_2) and particulate matter (both PM_{10} and $PM_{2.5}$)
- Proportion of roads exceeding the NO_2 targets
- Population exposure data for NO_2 and $PM_{2.5}$
- Air pollution exposure at schools, care homes and hospitals
- Bespoke borough packages including borough concentration maps and emissions dashboards

[5] Emissions published in August 2025 have been updated to account for revised emissions for Non-TfL buses and coaches from Road Transport sources to correct for allocation on the road network, and revised spatial distribution of the Industrial Part A1 emissions on the LAEI grid, now allocated to the correct grid ID.

World Health Organization (WHO) Air Quality Guidelines

In 2021, the WHO updated its recommended guidelines for air pollutants[6]. The new air quality guidelines reflect the best available health evidence and WHO's recommendations continue to be recognised globally as the targets that should be met to protect public health.

- For particulate matter (PM_{10}), it tightened the recommended annual average concentration guideline to 15 µg/m^3, while retaining 20 µg/m^3 as an interim target.
- For fine particulate matter ($PM_{2.5}$), it tightened the recommended annual average concentration guideline to 5 µg/m^3, while retaining 10 µg/m^3 as an interim target, which the Mayor committed to meet by 2030 within his London Environment Strategy.
- For nitrogen dioxide (NO_2) the WHO also tightened the recommended annual average guideline to 10 µg/m^3 (the previous WHO guideline was 40 µg/m^3), whilst introducing additional interim targets of 30 µg/m^3 and 20 µg/m^3, representing incremental steps to progressively reduce NO_2 levels and achieve the newly proposed air quality guideline level.

These changes underscore that, despite the significant progress made, accelerated additional action is needed to protect human health, since, as highlighted in the WHO air quality guidelines report 2021, available evidence cannot currently identify levels of exposure that are risk free. Delivering this action will require the Government to work with the Mayor of London. In addition, the Mayor may need further powers and additional funding to reach the WHO Air Quality Guidelines. The Mayor has commissioned a scientific and technical evaluation of what action would enable London to achieve its existing target of 10 µg/m^3 annual average $PM_{2.5}$ by 2030, and to reach full compliance with the WHO Guidelines.

Table 2: WHO recommended air quality guidelines and UK legal limits

Relationship between WHO guidelines and UK legal limits

The difference between the UK legal limits and the WHO Guidelines is summarised in the table below:

Pollutant	Averaging Time	WHO 2021 Guideline µg/m^3	UK Legal Limits µg/m^3
NO_2	Annual	10	40
PM_{10}	Annual	15	40
$PM_{2.5}$	Annual	5	20 (10 by 2040)

Following passage of the Environment Act 2021 the Government introduced two legally binding limits for fine particulate matter ($PM_{2.5}$):

- An annual mean concentration target ('concentration target') - a maximum concentration of 10 µg/m^3, to be met across England by 2040, and

[6] WHO global air quality guidelines: particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide. Available at https://www.who.int/publications/i/item/9789240034228

- A population exposure reduction target ('exposure target') - a 35 per cent reduction in population exposure by 2040 (compared to a base year of 2018).

Following recent updates to the Environmental Improvement Plan, the government has announced interim 2030 targets for fine particulate matter ($PM_{2.5}$). These include limiting the annual mean concentration to 10 µg/m³ and achieving a 30% reduction in population exposure compared with 2018 levels.

Existing legal limits, including those for the NO_2 annual and hourly means, remain in place.

The Mayor has long made the case for UK air pollution limits for all air pollutants to be aligned with the WHO recommended air quality guidelines, which are based on the best available health evidence. In the London Environment Strategy, the Mayor committed to achieving annual mean concentrations of 10 $\mu g/m^3$ of $PM_{2.5}$ by 2030, a full decade before the new UK legal limits; the LAEI data demonstrates that this can be achieved.

Action to Improve Air Quality

The improvements in pollution levels seen are due to a number of different factors including the Mayor's work to improve air quality with schemes such as the ULEZ and its expansion; the London-wide LEZ for heavy vehicles; the Non Road Mobile Machinery Low Emission Zone; planning policies such as the Air Quality Positive and Neutral policies; progressive taxi licencing schemes and installation of electric vehicle charge points. Local action by boroughs has also brough improvements to pollution hotspots. Such action has accelerated the reduction in emissions and improvement in air quality concentrations above and beyond that of the natural churn of the vehicle fleet.

Emissions Methodology Updates

It is important to note that a full update of emissions (based on the latest detailed activity data and emission factor database and methodology improvements at the time of compilation of the inventory) has only been carried out for the new baseline year 2022. Emissions estimates from previous baseline years (2016, 2019) and forecast years (2025, 2030), remain as previously reported in the LAEI 2019 except for the following sources, where changes in methodology, revised historical activity data or emission factors were deemed significant enough to warrant a revision of emission estimates previously published for these sources, due to the impact they had on overall trends. These include:

- An increase in road transport emissions, due to the revision of motor vehicle statistics on minor roads across Great Britain published by Department for Transport (DfT), which resulted in increases in overall vehicle-kilometre estimates across London and the LAEI area. The effect of this revision by DfT on traffic volume estimates on London roads was discussed in TfL's Travel in London reports[7]. These changes could not be included at the time the LAEI 2019 was prepared but have now been incorporated in the LAEI 2022. For previous baseline years and forecast years, an overall scaling factor was applied to road transport emissions, to reflect the minor road methodology changes. However, the underlying traffic trends are the same as in the LAEI 2019. Revised forecast of traffic volumes accounting for both the DfT minor road changes and new forecasts for traffic post-pandemic will be incorporated in the next LAEI update.
- An increase in PM aviation emissions, linked to the stationary sources at Heathrow Airport, which saw a significant increase in emissions from the biomass CHP plant. Note that emissions from previous baselines have not been revised; only those for forecast years 2025 and 2030 have been updated by replacing estimated emissions for the stationary sources at Heathrow, (using those reported in the Heathrow Airport emission inventory 2022[8] instead of the previous emissions reported in the LAEI 2019).
- An increase in domestic emissions associated to the combustion of residual fuel (i.e. not natural gas) for heat and power generation, aligned with the latest revision of residual fuel consumption for UK local authorities from DESNZ[9].

These revisions mean that overall, LAEI emission estimates for 2016, 2019 and forecast for 2025 and 2030 are slightly higher than previously reported as part of the LAEI 2019. For example, revised 2019 emissions for London (GLA area) are 4 per cent higher for NO_x, 2.5 per cent higher for PM_{10} and 2 per cent higher for $PM_{2.5}$.

Finally, for PM emissions, previous estimates for commercial cooking have now been split between commercial cooking and domestic cooking, following a revision of the methodology. The previous totals from the LAEI 2019 remain unchanged, but the total has been split equally between these two categories, although the spatial distribution is different (as the commercial part of these emissions is based on the distribution of commercial premises, whilst the domestic part is based on the housing distribution across London), which means that this split varies by borough. Emissions for previous baseline years 2016 and 2019, and forecast years 2025 and 2030, have been split in a similar way.

Note that these revisions have been carried out at high level, based on overall scaling of previous emissions, and only apply to the above sources. However, forecast emissions for all sources will be fully revised in the next LAEI update. A full methodology document will be published alongside the LAEI 2022 concentrations data.

[7]Travel in London Report 14, TfL, 2021. Section 7.2 Overall trends for road traffic in London. Available at travel-in-london-report-14.pdf

[8] Heathrow Airport Airfield Emission Inventory 2022, Ricardo Energy & Environment, 2024. Available at Heathrow Airport Airfield Emission Inventory 2022

[9]Available at Sub-national residual fuel consumption data - GOV.UK. Note that DESNZ have also made revisions to non-domestic residual fuel consumption across the UK, but due to issues with aligning these spatially across London, these have not been included in the LAEI 2022, and further work will be required before including these changes in the next LAEI

Key Findings

Emissions Trends

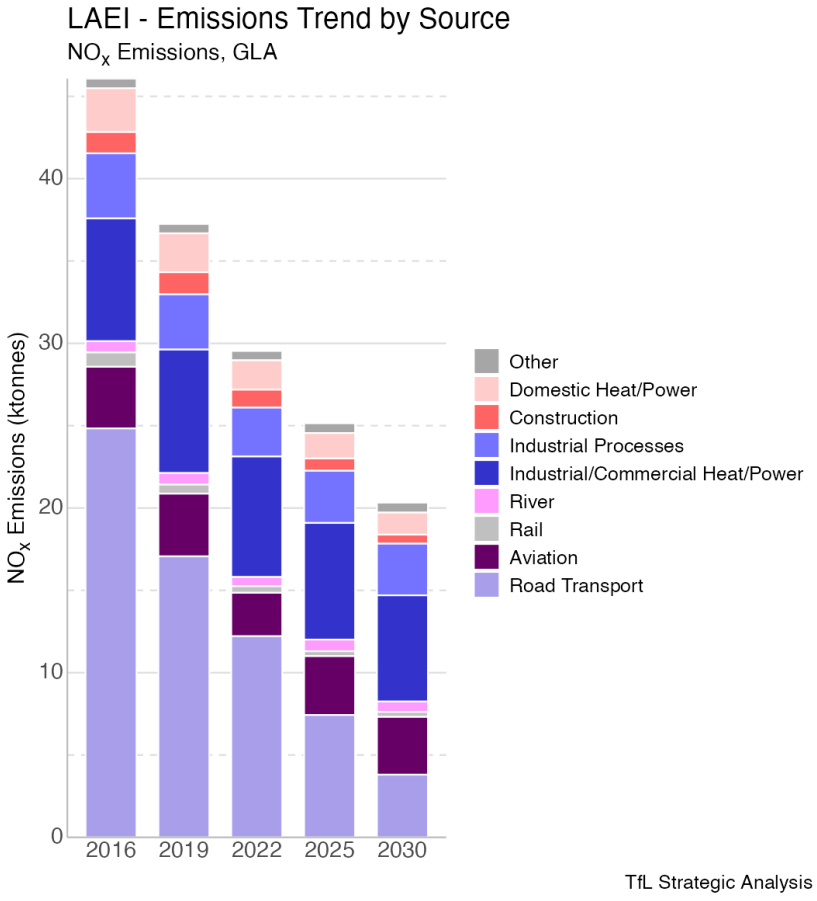
Nitrogen Oxides (NO_x)

Since 2016, there has been a significant reduction in total NO_x emissions across London. Figure 1 shows the trend in NO_x emissions per source. Compared to 2019, total NO_x emissions reduced by 21 per cent in Greater London in 2022. The largest reduction in (tonnes of) NO_x emissions is from road transport in London, with a decrease of nearly 5,000 tonnes. This equates to a reduction of 28 per cent in road transport emissions across London between 2019 and 2022.

Total NO_x emissions across London are forecast to be 15 per cent lower in 2025, and 31 per cent lower in 2030, compared to 2022 emission levels. Road transport NO_x emissions are expected to reduce by 39 per cent across London by 2025 and 69 per cent by 2030, compared to 2022, as the vehicle fleet continues to become cleaner, accelerated due to schemes such as the ULEZ.

Following the increase in forecast road transport emissions due to the revision of traffic volume statistics from DfT, by 2025 road transport will still be the dominant source of NO_x across London (30 per cent of total NO_x), although closely followed by the industrial and commercial heat and power generation source category (28 per cent, see Figure 10). However, by 2030, it is still expected that the latter will overtake road transport as the main source of NO_x across London (see further details page24).

Figure 1 - NO_x Emissions Trend by Source in Greater London



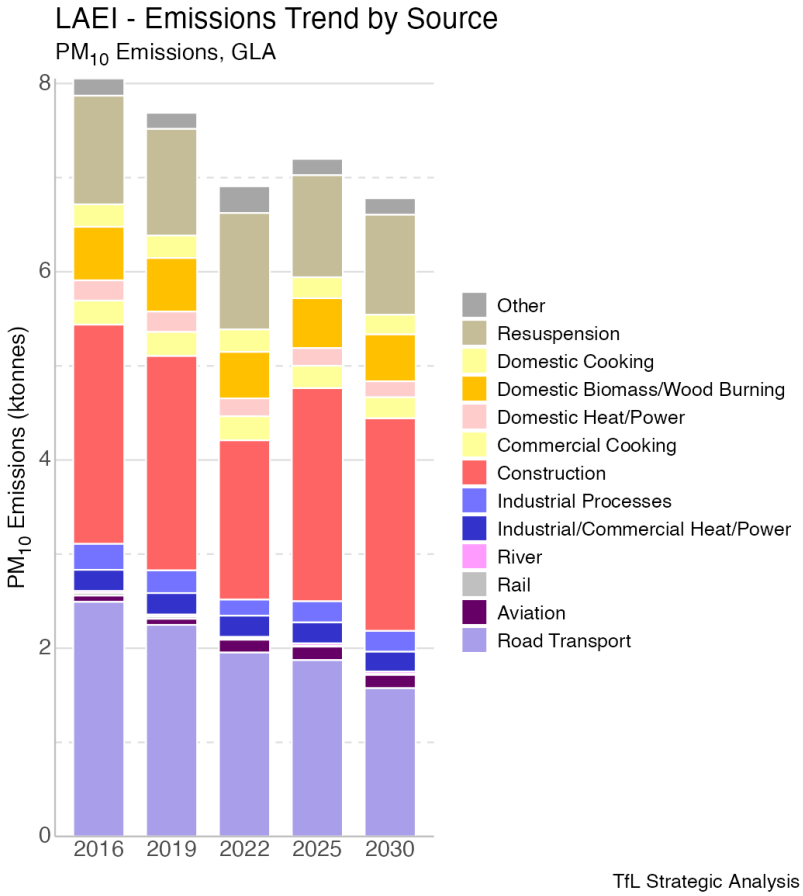
Particulate Matter (PM_{10})

Figure 2 shows the trend in PM_{10} emissions per source. Emissions for 2022 confirm the long-term trend showing a gradual reduction in total PM_{10} over the years. As seen in Figure 14, in 2022 road transport emissions were the largest single source of PM_{10}, accounting for 28 per cent of total emissions in London, followed by construction at 25 per cent and resuspension at 18 per cent.

The largest reductions in (tonnes of) PM_{10} emissions in London are from construction, then road transport sectors, with a decrease of about 600 and 300 tonnes respectively This equates to a reduction of 26 per cent in construction emissions and 13 per cent in road transport emissions across London between 2019 and 2022. It is however important to note that construction emissions estimates are subject to significant uncertainty, inherent to the methodology and data used to calculate emissions.

Total PM_{10} emissions across London are forecast to be2 per cent lower in 2030, compared to 2022 emission levels.

Figure 2 - PM_{10} Emissions Trend by Source in Greater London



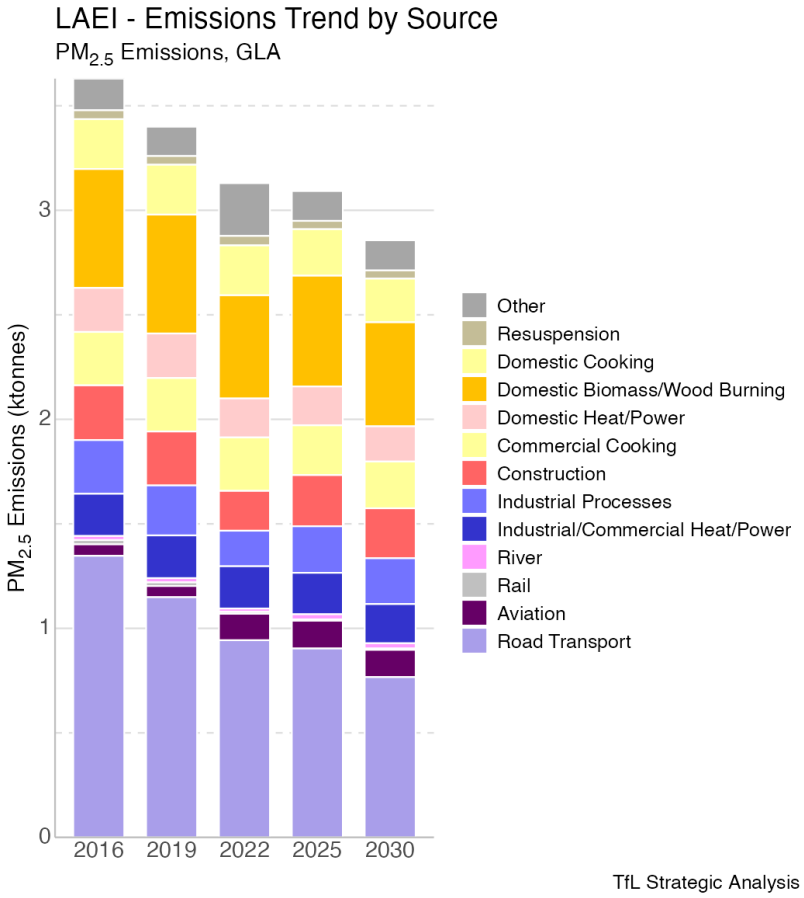
Particulate Matter ($PM_{2.5}$)

Figure 3 shows the trend in $PM_{2.5}$ emissions per source. Emissions for 2022 confirm the long-term trend showing a continuing reduction in total $PM_{2.5}$ over the years. As seen in Figure 19, in 2022 road transport emissions contributed the largest single source of $PM_{2.5}$ accounting for 30 per cent of total emissions in London, followed by domestic wood burning at 16 per cent.

In 2022, total $PM_{2.5}$ emissions in London reduced by 8 per cent compared to 2019, building upon the reduction of 6 per cent that was observed between 2016 to 2019. The largest reduction in (tonnes of) $PM_{2.5}$ emissions is from road transport, with a decrease of more than 200 tonnes across London.

Total $PM_{2.5}$ emissions across London are forecast to be 1 per cent lower in 2025, and 9 per cent lower in 2030, compared to 2022 emission levels.

Figure 3 - $PM_{2.5}$ Emissions Trend by Source in Greater London



Concentration Trends

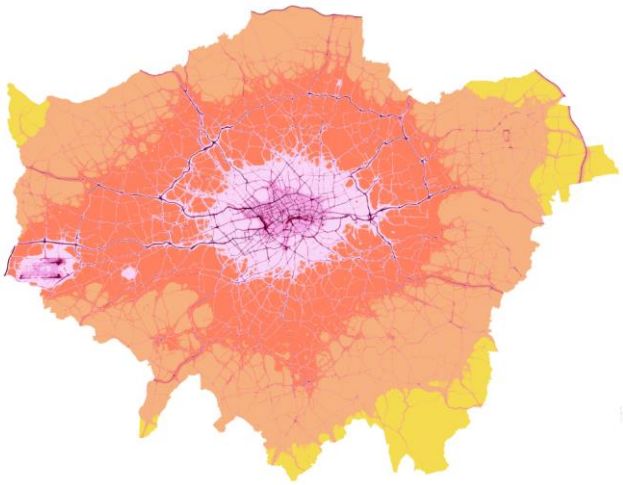
The LAEI 2022 provides maps of modelled annual mean concentrations across Greater London for NO_2 (Figure 4), PM_{10} (Figure 5) and $PM_{2.5}$ (

Figure 6) for 2022. Previous LAEI maps from the 2019 base year, as published in the LAEI 2019, are also provided for comparison.

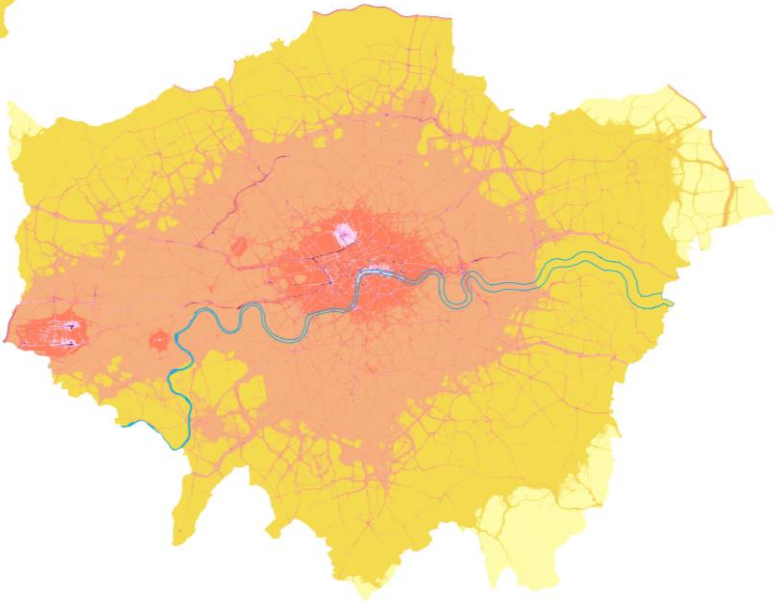
Nitrogen Dioxide (NO_2)

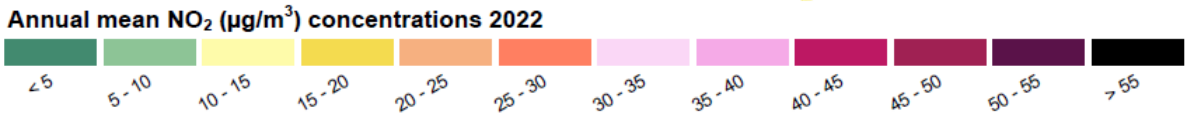
Figure 4 – Modelled NO_2 annual mean concentrations across Greater London in 2022 (2019 for reference)

2019



2022





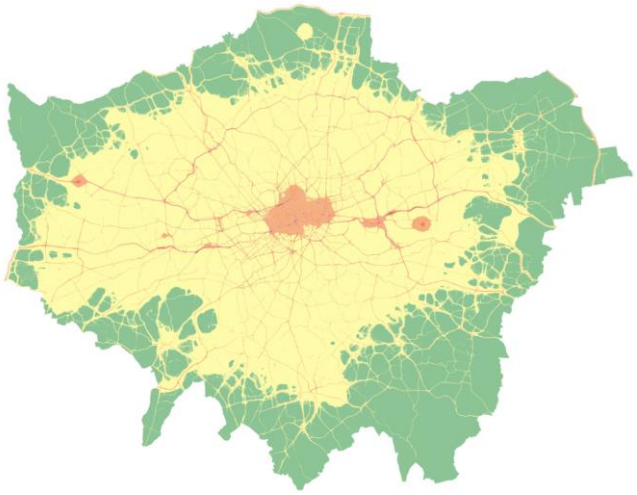
NO_2 concentrations across Greater London in Figure 4 have reduced, with 2022 levels about 21 per cent lower than in 2019. In 2022, about 50 per cent of London met the WHO interim annual average target of 20 µg/m^3. This improvement is likely linked to measures such as the expansion of the ULEZ (up to the North and South Circular roads) in 2021 and cleaner vehicle technologies. However, concentrations for 2022 show that nowhere in London met the stricter WHO guideline of 10 µg/m^3, highlighting the need for further action to meet optimal health standards. Continued reductions are expected due to the ULEZ expansion to cover the entire London area in August 2023 as well as electric vehicle uptake.

Particulate Matter (PM_{10})

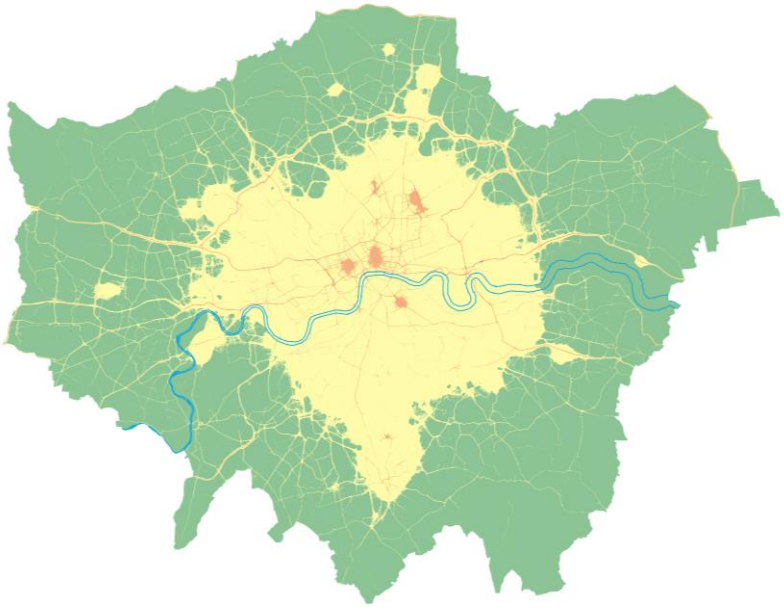
> Note that PM_{10} is a transboundary pollutant and therefore concentrations are heavily influenced by meteorology, background concentrations and sources outside of London, including on the continent, on top of local emissions. Therefore, local transport policies to reduce emissions, such as the ULEZ, will have a smaller impact on concentrations.

Figure 5 – Modelled PM_{10} annual mean concentrations across Greater London in 2022 (2019 for reference)

2019



2022



PM_{10} concentrations across Greater London have declined, with annual averages in 2022 approximately 7.2 per cent lower than in 2019. In 2022 large areas of outer London met the WHO annual average guideline of 15 µg/m^3 for PM_{10}.

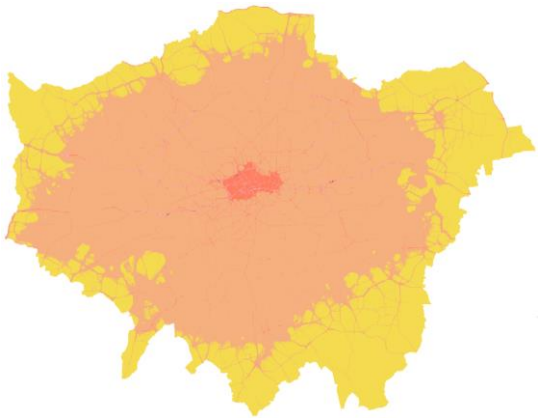
However, PM_{10} concentrations are strongly influenced by meteorology, background levels and sources from outside London, and local air quality transport policies such as ULEZ have a smaller impact on PM_{10} levels compared to NO_2. In 2022, the largest source of PM_{10} emissions was construction, while road transport accounted for 25 per cent of total emissions, influenced by mayoral policies like the ULEZ.

Particulate Matter ($PM_{2.5}$)

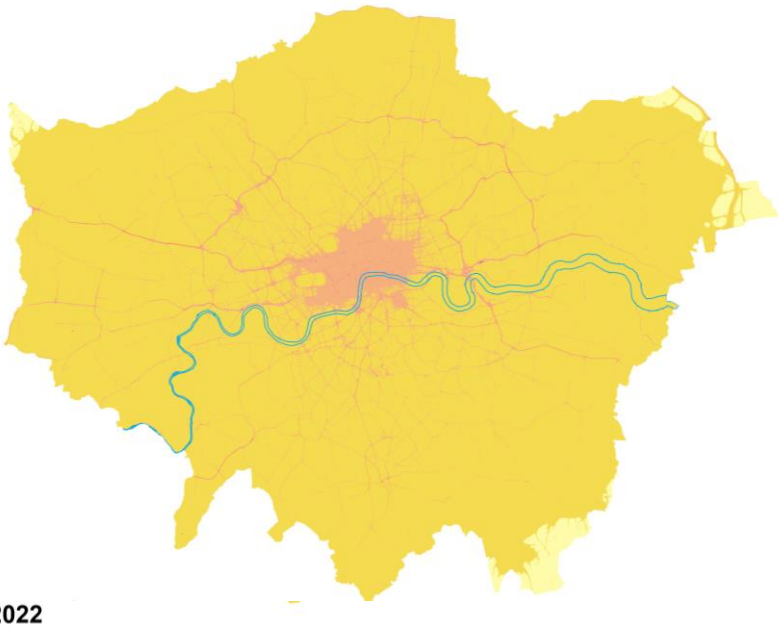
> Note that PM_{10} is a transboundary pollutant and therefore concentrations are heavily influenced by meteorology, background concentrations and sources outside of London, including on the continent, on top of local emissions. Therefore, local transport policies to reduce emissions, such as the ULEZ, will have a smaller impact on concentrations.

Figure 6 – Modelled $PM_{2.5}$ annual mean concentrations across Greater London in 2022 (2019 for reference)

2019



2022



$PM_{2.5}$ concentration maps in

Figure 6 show a decline across Greater London, with annual averages in 2022 approximately 15 per cent lower than in 2019 (including both background and roadside locations). For the first time in 2022, mostly all London apart from the central London area met the WHO interim target of 10 µg/m^3 for $PM_{2.5}$. This indicates that achieving this level citywide is possible. Nevertheless, nowhere in London met the stricter WHO guideline of 5 µg/m^3.

Like PM_{10}, $PM_{2.5}$ is a transboundary pollutant, with concentrations significantly influenced by regional background levels and meteorology. Although local existing policies have resulted in significant improvements, more needs to be done at a local, national and international level to fully address the issue.

Major Roads Meeting Air Quality Targets

The proportion of major road lengths exceeding NO_2 WHO air quality guidelines (interim targets 30 µg/m^3, 20 µg/m^3 and guideline 10 µg/m^3) have been assessed. This is estimated based on analysis of concentrations along the edge of roads at approximately 4m distance.

A weighted average along the distance of each road link is used as the concentration varies alongside roads depending on traffic flows and geography, including road width and dispersive characteristics such as tall street canyons and road type. This method presents a reasonably conservative estimate of how compliance against national legal limits is being achieved in London. It should be noted that although the formal assessment of compliance is undertaken by Defra using their Pollution Climate Mapping model, using this methodology for the LAEI provides a useful way of comparing progress.

Analysis of the London's major roads network demonstrates that almost all of London's roads comply with the 40 µg/m^3 legal UK limit. However, there are still exceedances for WHO air quality guidelines and interim targets for NO_2.

- None of the London's major roads met the annual mean guideline of 10 µg/m^3 in 2019, and this remains unchanged in 2022 (see Table 5).
- No major roads met the WHO interim target of 20 µg/m^3 in 2019. This has improved in 2022 with 14 per cent of the major roads meeting this target (see
-
- Table 4). The roads meeting 20 µg/m^3 in 2022 are in the outer London area only, with 22 per cent of major roads complying.
- 37 per cent of London's roads were meeting WHO interim target of 30 µg/m^3 in 2019, and this has increased to 87 per cent in 2022. A breakdown by area shows some variation, with 33 per cent of the major roads in central, 78 per cent in inner and 94 per cent in outer London areas meeting the 30 µg/m^3 interim target (see table 3).
- 99 per cent of London's roads now meet the annual mean limit value of 40 µg/m^3 for NO_2 in the UK.

These trends reflect the combined impact of Mayor's air quality interventions in London.

Table 3: Proportion of Major Roads Network Length Below/Over the NO_2 Annual Mean WHO interim target of 30 µg/m³

WHO interim target 30 µg/m³ annual average	Exceeding Central	Meeting Central	Exceeding Inner Zone	Meeting Inner Zone	Exceeding Outer Zone	Meeting Outer Zone	Exceeding GLA	Meeting GLA
LAEI 2019 baseline	100%	0%	91%	9%	50%	50%	63%	37%
LAEI 2022 baseline	68%	33%	22%	78%	6%	94%	13%	87%

Table 4: Proportion of Major Roads Network Length Below/Over the NO_2 Annual Mean WHO interim target of 20 µg/m³

WHO interim target 20 µg/m³ annual average	Exceeding Central	Meeting Central	Exceeding Inner Zone	Meeting Inner Zone	Exceeding Outer Zone	Meeting Outer Zone	Exceeding GLA	Meeting GLA
LAEI 2019 baseline	100%	0%	100%	0%	99%	1%	100%	0%
LAEI 2022 baseline	100%	0%	100%	0%	78%	22%	86%	14%

Table 5: Proportion of Major Roads Network Length Below/Over the NO_2 Annual Mean WHO guideline of 10 µg/m³

WHO 10 µg/m³ annual average guideline	Exceeding Central	Meeting Central	Exceeding Inner Zone	Meeting Inner Zone	Exceeding Outer Zone	Meeting Outer Zone	Exceeding GLA	Meeting GLA
LAEI 2019 baseline	100%	0%	100%	0%	100%	0%	100%	0%
LAEI 2022 baseline	100%	0%	100%	0%	100%	0%	100%	0%

Transport for London Road Network (TLRN) or London's 'Red Routes'

London's red routes form a network of major roads that only make up 5 per cent of the roads, however it represents up to 30 per cent of the city's traffic. Analysis on the TLRN only indicates that:

- None of the TLRN is meeting the WHO annual mean air quality guideline of 10 µg/m^3 for NO_2 in 2019 or in 2022.
- None of the TLRN met the WHO interim annual mean air quality target of 20 µg/m^3 for NO_2 in 2019, and 7 per cent of the TLRN has met this value in 2022.
- 21 per cent of the TLRN met the WHO interim annual mean air quality target of 30 µg/m^3 for NO_2 in 2019. This has increased to 76 per cent in 2022.
- 76 per cent of the TLRN roads met the UK annual mean limit value of 40 µg/m^3 for NO_2 in 2019. In 2022, this proportion has increased to 98 per cent.

Population Exposure

A population weighted average method at Output Area (OA) level has been used to measure population exposure across London. This calculation measures the average level of exposure for a population by giving more importance to areas with higher populations. The concentration mean in each OA is multiplied by the number of people living in the OA. These products are then summed and divided by the total population.

The population exposure data indicates a substantial reduction in the number of Londoners living in areas of high pollution, although compliance with the WHO guidelines remains a challenge.

Nitrogen Dioxide (NO_2)

- All Londoners lived in areas exceeding the WHO recommended annual mean guideline of 10 µg/m^3 in 2019 and this has continued to remain the case in 2022.
- In 2019, almost 9 million (99 per cent) of Londoners were exposed to NO_2 concentrations above the WHO interim target of 20 µg/m^3. This figure fell to over 6 million (70 per cent) of Londoners in 2022. Most residents living in central and inner London areas are still in areas exceeding this interim target in 2022.
- All central London residents lived in areas exceeding the WHO interim annual mean target of 30 µg/m^3 in 2019, but population exposure has declined sharply with 22 per cent of those living in central London exceeding this interim target in 2022. Across Greater London, over 2 million people (32 per cent) were exposed levels of NO_2 exceeding this target in 2019, reducing to approximately 140,000 (2 per cent) in 2022.
- In 2022, most people in London lived in areas that meet the annual mean UK limit value of 40 µg/m^3 for NO_2, with around 1,000 Londoners living in areas where this limit is exceeded.
- In 2022, the average annual mean concentrations of NO_2 that Londoners were exposed to were approximately 21% lower compared to 2019. These estimates include both background and roadside locations because the population estimates are based on average concentrations across census output areas, based on dispersion modelling at 20m resolution.

Particulate Matter ($PM_{2.5}$)

- All Londoners continued to live in areas exceeding the WHO recommended annual mean guideline of 5 µg/m^3 for $PM_{2.5}$ in 2022.
- In 2019, 11 per cent of the London population, primarily in outer London only, were living in areas meeting the WHO interim annual mean target of 10 µg/m^3. In 2022, the proportion of Londoners living in areas below the 10 µg/m^3 interim target rose to 88 per cent.
- Annual mean $PM_{2.5}$ concentrations that people were exposed to in 2022 were 24 per cent lower compared to 2019. These estimates include both background and roadside locations.

Schools

Analysis on concentration data allows us to determine the number of each type of educational facility located in areas exceeding the WHO NO_2 annual mean interim targets (30 µg/m^3, 20 µg/m^3) and final guideline (10 µg/m^3), as well as those in areas exceeding the WHO $PM_{2.5}$ annual mean interim target (10 µg/m^3) and final guideline (5 µg/m^3) in 2019 and 2022. The concentration figures have been calculated as an average within a 150m buffer of each educational establishment.

Please note that the figures shown for 2019 in Table 6 and Table 7 are those published when the LAEI 2019 analysis was done, based on the list of educational establishments used at the time, and also derived from the Department of Education.

Nitrogen Dioxide (NO_2)

- All educational establishments were located in areas where NO_2 annual mean concentrations exceeded the WHO guideline of 10 µg/m³ in both 2019 and 2022.
- Table 7 shows that, in 2019, 99 per cent of educational establishments exceeded the stricter WHO interim annual mean target of 20 µg/m^3 for NO_2 this reduced to 69 per in 2022.
- For state primary and secondary schools, 99 per cent exceeded the 20 µg/m^3 interim target in 2019, the number was down to 65 per cent in 2022.
- In 2019, 32 per cent of educational establishments were located in areas exceeding the WHO interim annual mean target of 30 µg/m^3 for NO_2. This number decreased significantly to 1.6 per cent in 2022 (see Table 6).
- Among state primary and secondary schools, 27 per cent exceeded the 30 µg/m^3 target in 2019 and this number reduced to 1 per cent in 2022.
- All educational establishments across London met the UK annual mean limit value of 40 µg/m^3 for NO_2.

Table 6: Schools exceeding the NO_2 Annual Mean WHO Interim Air Quality Target of 30 µg/m³

Educational Establishment Type	LAEI 2019 baseline			LAEI 2022 baseline		
	Total number of schools	Number exceeding 30 µg/m^3 NO_2 2019	% Exceeding 30 µg/m^3 NO_2 2019	Total number of schools	Number exceeding 30 µg/m^3 NO_2 2022	% Exceeding 30 µg/m^3 NO_2 2022
Nursery	79	38	48%	75	1	1%
Primary	1803	492	27%	1762	16	1%
Secondary	459	114	25%	459	7	2%
16 plus	46	25	54%	47	2	4%
Community Special School	81	31	38%	77	1	1%
Higher Education Institutions	36	25	69%	36	6	17%
Other Independent School	475	224	47%	430	14	3%
Other Independent Special School	52	20	38%	83	0	0%
Pupil Referral Unit	36	11	31%	34	0	0%
Other	188	62	33%	206	4	2%
Total	3255	1042	32%	3209	51	2%

Table 7: Schools exceeding the NO_2 Annual Mean WHO Interim Air Quality Target of 20 µg/m³

Educational Establishment Type	LAEI 2019 baseline			LAEI 2022 baseline		
	Total number of schools	Number exceeding 20 µg/m³ NO_2 2019	% Exceeding 20 µg/m³ NO_2 2019	Total number of schools	Number exceeding 20 µg/m³ NO_2 2022	% Exceeding 20 µg/m³ NO_2 2022
Nursery	79	79	100%	75	66	88%
Primary	1803	1784	99%	1762	1153	65%
Secondary	459	447	97%	459	287	63%
16 plus	46	46	100%	47	36	77%
Community Special School	81	81	100%	77	54	70%
Higher Education Institutions	36	36	100%	36	34	94%
Other Independent School	475	474	100%	430	351	82%
Other Independent Special School	52	50	96%	83	57	69%
Pupil Referral Unit	36	36	100%	34	23	68%
Other	188	185	98%	206	138	67%
Total	3255	3218	99%	3209	2199	69%

Particulate Matter ($PM_{2.5}$)

- As shown in Table 9, all educational establishments were above the WHO air quality guideline of 5 µg/m³ annual average for $PM_{2.5}$ throughout 2019 and 2022.
- Analysis of $PM_{2.5}$ annual mean concentrations in Table 8 show that, in 2019, 88 per cent of schools were located in areas exceeding the WHO interim target of 10 µg/m³. This number decreased to 11 per cent in 2022, reflecting a marked improvement.

Table 8: Schools exceeding the $PM_{2.5}$ Annual Mean WHO Interim Air Quality Target of 10 µg/m³

Educational Establishment Type	LAEI 2019 baseline			LAEI 2022 baseline		
	Total number of schools	Number exceeding 10 µg/m³ $PM_{2.5}$ 2019	% Exceeding 10 µg/m³ $PM_{2.5}$ 2019	Total number of schools	Number exceeding 10 µg/m³ $PM_{2.5}$ 2022	% Exceeding 10 µg/m³ $PM_{2.5}$ 2022
Nursery	79	79	100%	75	10	13%
Primary	1803	1580	88%	1762	150	9%
Secondary	459	382	83%	459	38	8%
16 plus	46	43	93%	47	14	30%
Community Special School	81	74	91%	77	9	12%
Higher Education Institutions	36	33	92%	36	22	61%
Other Independent School	475	444	93%	430	85	20%
Other Independent Special School	52	48	92%	83	11	13%
Pupil Referral Unit	36	32	89%	34	4	12%
Other	188	164	87%	206	18	9%
Total	3255	2879	88%	3209	361	11%

Table 9: Schools exceeding the $PM_{2.5}$ Annual Mean WHO Air Quality guideline of 5 µg/m³

Educational Establishment Type	LAEI 2019 baseline			LAEI 2022 baseline		
	Total number of schools	Number exceeding 5 µg/m³ $PM_{2.5}$ 2019	% Exceeding 5 µg/m³ $PM_{2.5}$ 2019	Total number of schools	Number exceeding 5 µg/m³ $PM_{2.5}$ 2022	% Exceeding 5 µg/m³ $PM_{2.5}$ 2022
Nursery	79	79	100%	75	75	100%
Primary	1803	1803	100%	1762	1762	100%
Secondary	459	459	100%	459	459	100%
16 plus	46	46	100%	47	47	100%
Community Special School	81	81	100%	77	77	100%
Higher Education Institutions	36	36	100%	36	36	100%
Other Independent School	475	475	100%	430	430	100%
Other Independent Special School	52	52	100%	83	83	100%
Pupil Referral Unit	36	36	100%	34	34	100%
Other	188	188	100%	206	206	100%
Total	3255	3255	100%	3209	3209	100%

Hospitals

Analysis of concentration data enables the identification of the number of hospitals in London located in areas exceeding the WHO air quality guidelines for NO_2 and for $PM_{2.5}$ in 2022. These concentration values have been calculated as averages within a 150m buffer surrounding each hospital.

Please note that earlier analysis for 2019 baseline suggested slightly different numbers than these now reported. The variation is due to an updated and more accurate version of the hospital database used in this analysis, extracted from NHS Digital, the statutory custodian for health and care data in England.

As illustrated in Table 10, in 2019 and 2022, all hospitals were located in areas where annual average NO_2 concentrations exceed the WHO guideline of 10 µg/m³. For the WHO interim target of 20 µg/m³, 98 per cent of hospitals were in areas of exceedance in 2019. This number decreased to 74 per cent in 2022. In relation to the WHO interim target of 30 µg/m³, 44 per cent exceeded this threshold in 2019, and this reduced to 10 per cent in 2022. All hospitals across London met the UK annual mean limit value of 40 µg/m³ for NO_2.

Regarding $PM_{2.5}$ concentrations, all hospitals remained above the WHO annual mean guideline of 5 µg/m³ in 2019 and 2022. For the WHO interim target of 10 µg/m³, 88 per cent of hospitals exceeded this level in both 2019 and 2022.

Table 10: Hospitals exceeding the NO_2 or $PM_{2.5}$ Annual Mean WHO Air Quality Guidelines

Hospitals		Total number	LAEI 2019 baseline		LAEI 2022 baseline	
			Number exceeding	% Exceeding	Number exceeding	% Exceeding
NO_2 Annual Mean	WHO Interim target (30 µg/m^3)	176	78	44%	17	10%
	WHO Interim target (20 µg/m^3)	176	172	98%	131	74%
	WHO Guideline (10 µg/m^3)	176	176	100%	176	100%
$PM_{2.5}$ Annual Mean	WHO Interim target (10 µg/m^3)	176	154	88%	154	88%
	WHO Guideline (5 µg/m^3)	176	176	100%	176	100%

Care Homes

Analysis of concentration data enables the identification of the number of care homes located in areas exceeding the WHO air quality guidelines for NO_2 and for $PM_{2.5}$ for 2022. These concentration values have been calculated as averages within a 150m buffer surrounding each care home facility.

Please note that earlier analysis for 2019 baseline suggested slightly different numbers than these now reported. The variation is due to an updated and more accurate version of the care home database used in this analysis, extracted from NHS Digital, the statutory custodian for health and care data in England.

As shown in Table 11, all care homes were in areas where annual average NO_2 concentrations exceed the WHO guideline of 10 µg/m³ in 2019 and 2022. For the WHO interim target of 20 µg/m³, 99 per cent of care homes in London were in areas of exceedance in 2019. This fell to 56 per cent in 2022. In relation to the WHO interim target of 30 µg/m³, 13 per cent were in areas of exceedance in 2019, while only one was in an area of exceedance in 2022. All care homes across London were in areas that met the UK annual mean limit value of 40 µg/m^3.

Regarding $PM_{2.5}$ concentrations, all care homes were in areas above the WHO annual mean guideline of 5 µg/m³ in 2019 and 2022. For the WHO interim target of 10 µg/m³, 82 per cent of care homes were in areas that exceeded this level in 2019 and 5 per cent were in areas that exceeded it in 2022.

Table 11: Care Homes exceeding the NO_2 or $PM_{2.5}$ Annual Mean WHO Air Quality Guidelines

Care Homes		Total number	LAEI 2019 baseline		LAEI 2022 baseline	
			Number exceeding	% Exceeding	Number exceeding	% Exceeding
NO_2 Annual Mean	WHO Interim target (30 µg/m^3)	663	87	13%	1	0%
	WHO Interim target (20 µg/m^3)	663	659	99%	374	56%
	WHO Guideline (10 µg/m^3)	663	663	100%	663	100%
$PM_{2.5}$ Annual Mean	WHO Interim target (10 µg/m^3)	663	543	82%	33	5%
	WHO Guideline (5 µg/m^3)	663	663	100%	663	100%

Emissions Data – Source Apportionment

The LAEI provides a breakdown of pollutant emissions by source, for 1km grid square resolution. The summary charts below show that, in 2022, the largest contributing source for NO_x, PM_{10} and $PM_{2.5}$ emissions was from road transport at 41 per cent, 28 per cent and 30 per cent respectively.

Figure 19 also shows that domestic biomass/wood burning is a significant contributor at 15 per cent of total $PM_{2.5}$ emissions.

The contribution by source from 2016 is also provided for comparison. For NO_x, it shows a similar source apportionment compared to 2022, although the road transport NO_x contribution reduced notably (54 per cent in 2016 vs. 41 per cent in 2022), whilst the contribution of industrial/commercial heat and power combustion sources increased (from 16 per cent in 2016 to 25 per cent in 2022). Over time the road transport contribution is becoming less dominant, with similar levels to industrial/commercial heat in 2025 (30 per cent and 28 per cent respectively) and by 2030 it is expected to no longer be the main source of NO_x.

Similarly for PM, the road transport contribution reduced from 31 per cent in 2016 to 28 per cent in 2022 (PM_{10}), and 37 per cent in 2016 to 30 per cent in 2022 ($PM_{2.5}$).

Figure 7 - 2016 NO_x Emissions by Source in Greater London

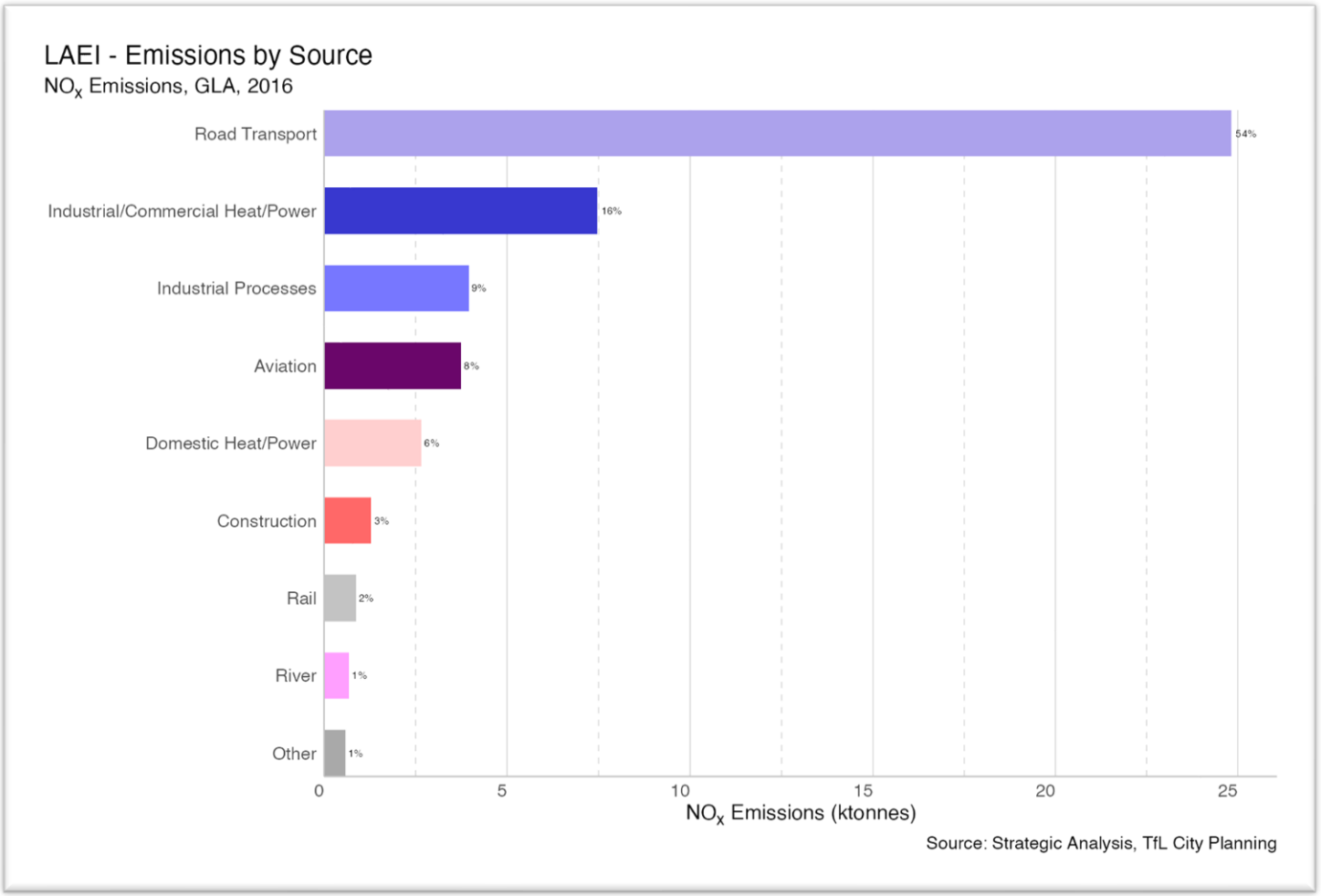


Figure 8 - 2019 NO_x Emissions by Source in Greater London

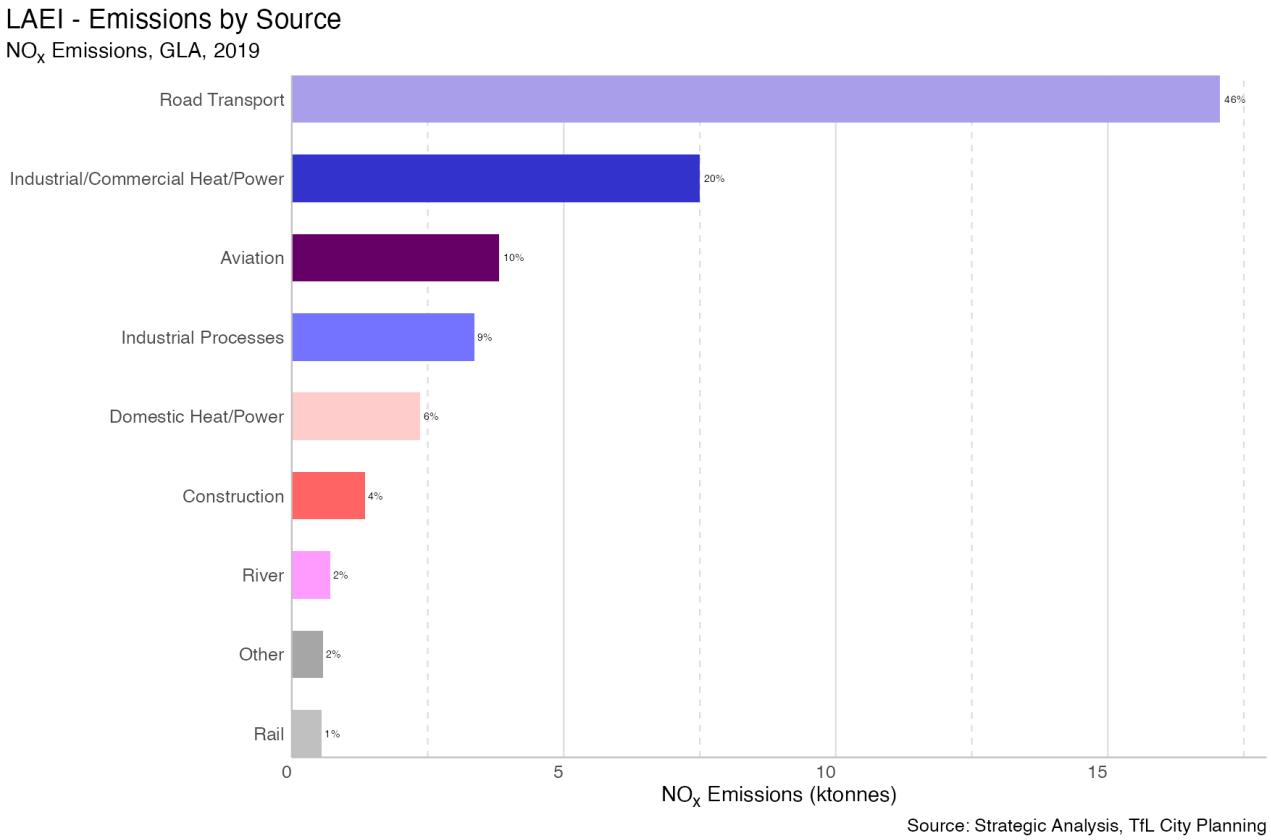


Figure 9 - 2022 NO_x Emissions by Source in Greater London

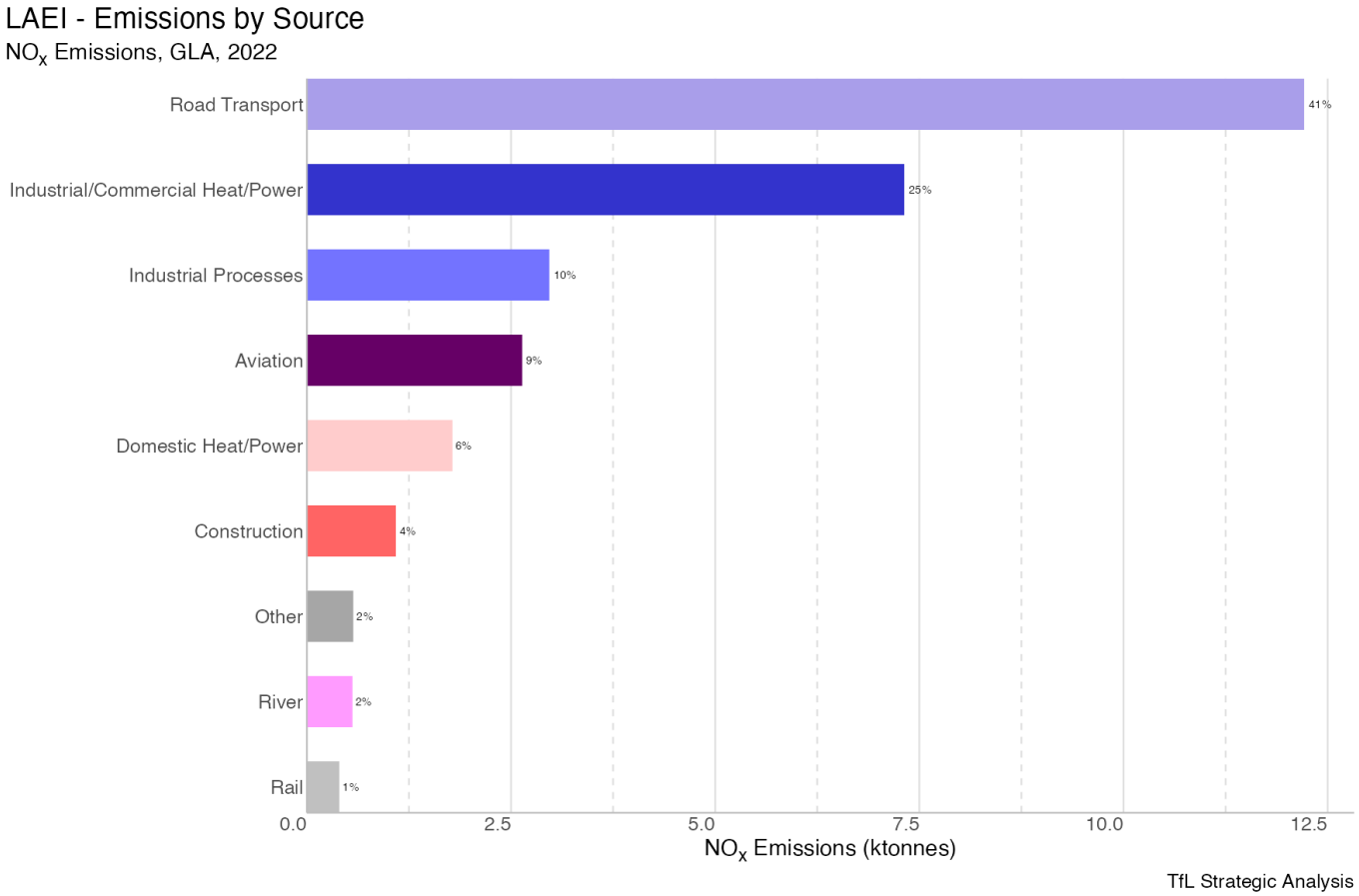


Figure 10 - 2025 NO_x Emissions by Source in Greater London

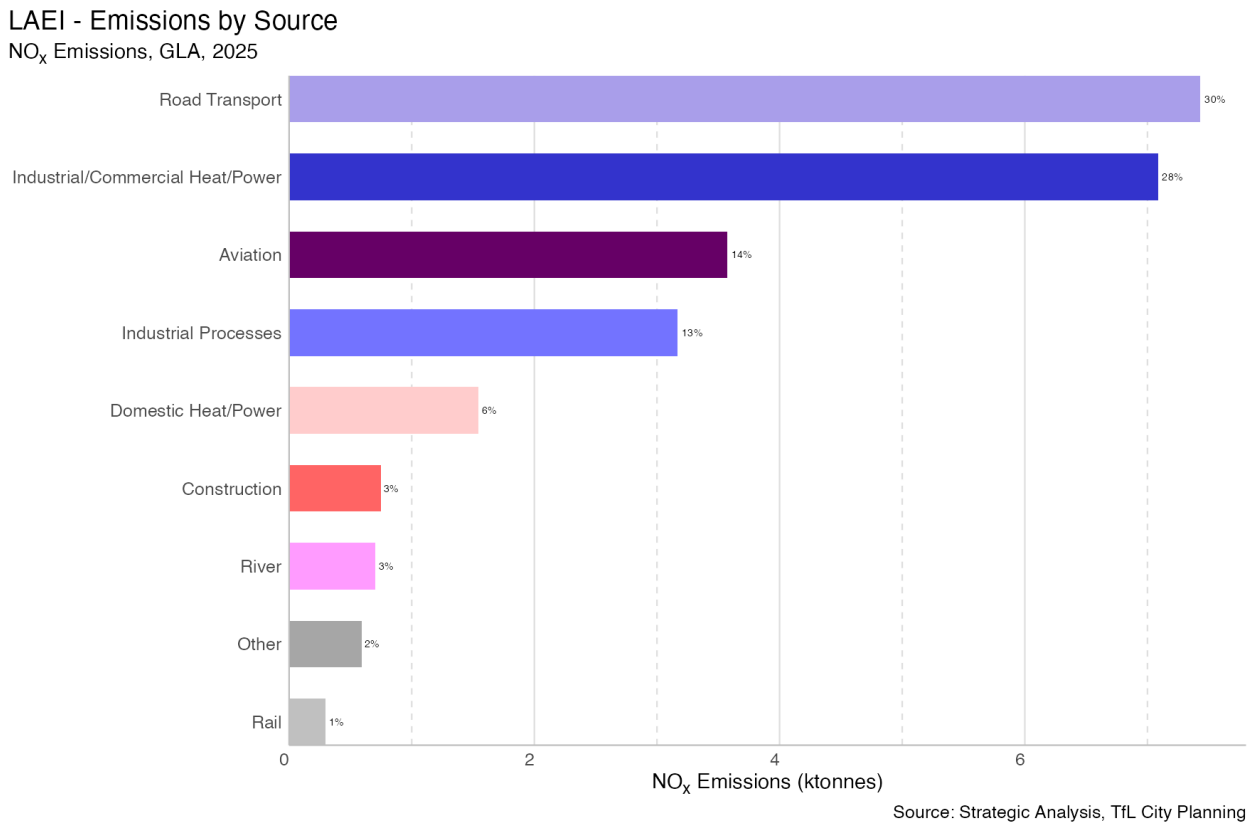


Figure 11 - 2030 NO_x Emissions by Source in Greater London

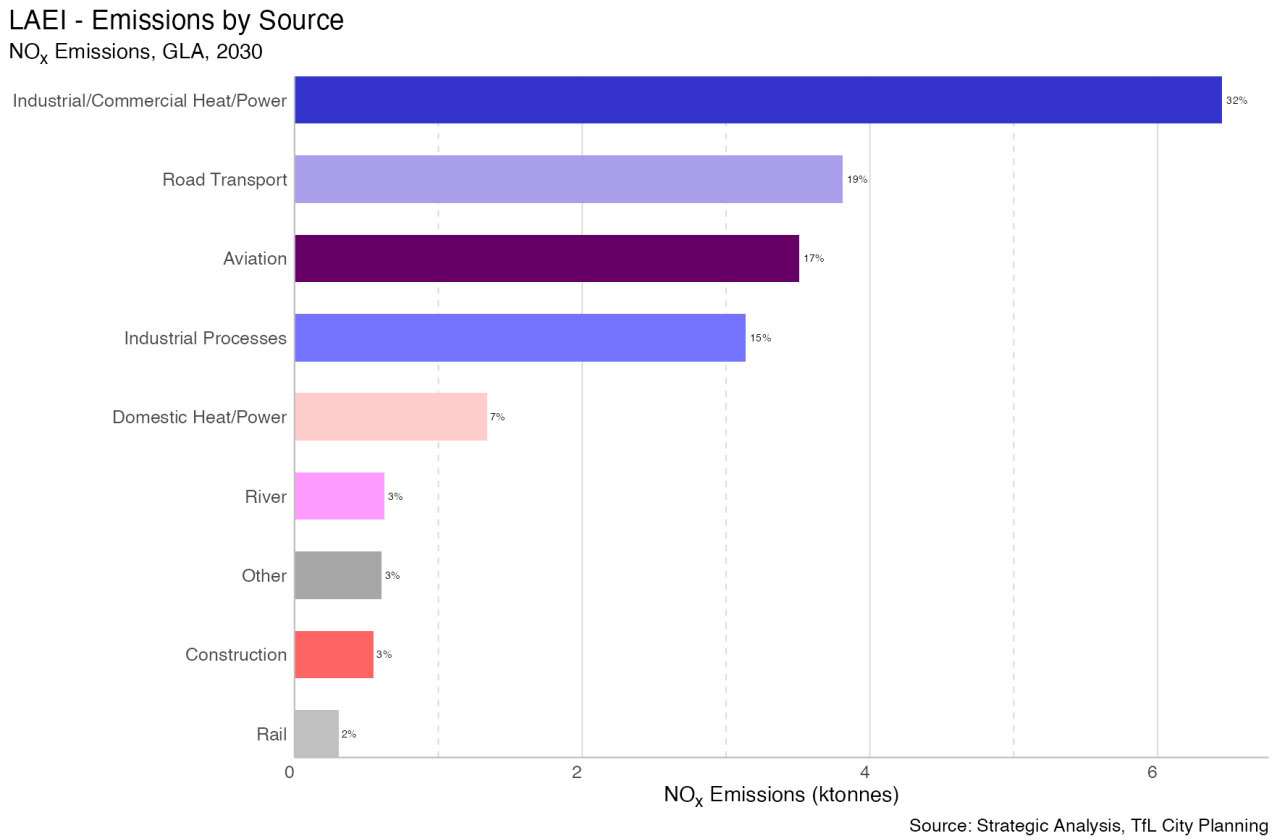


Figure 12 - 2016 PM_{10} Emissions by Source in Greater London

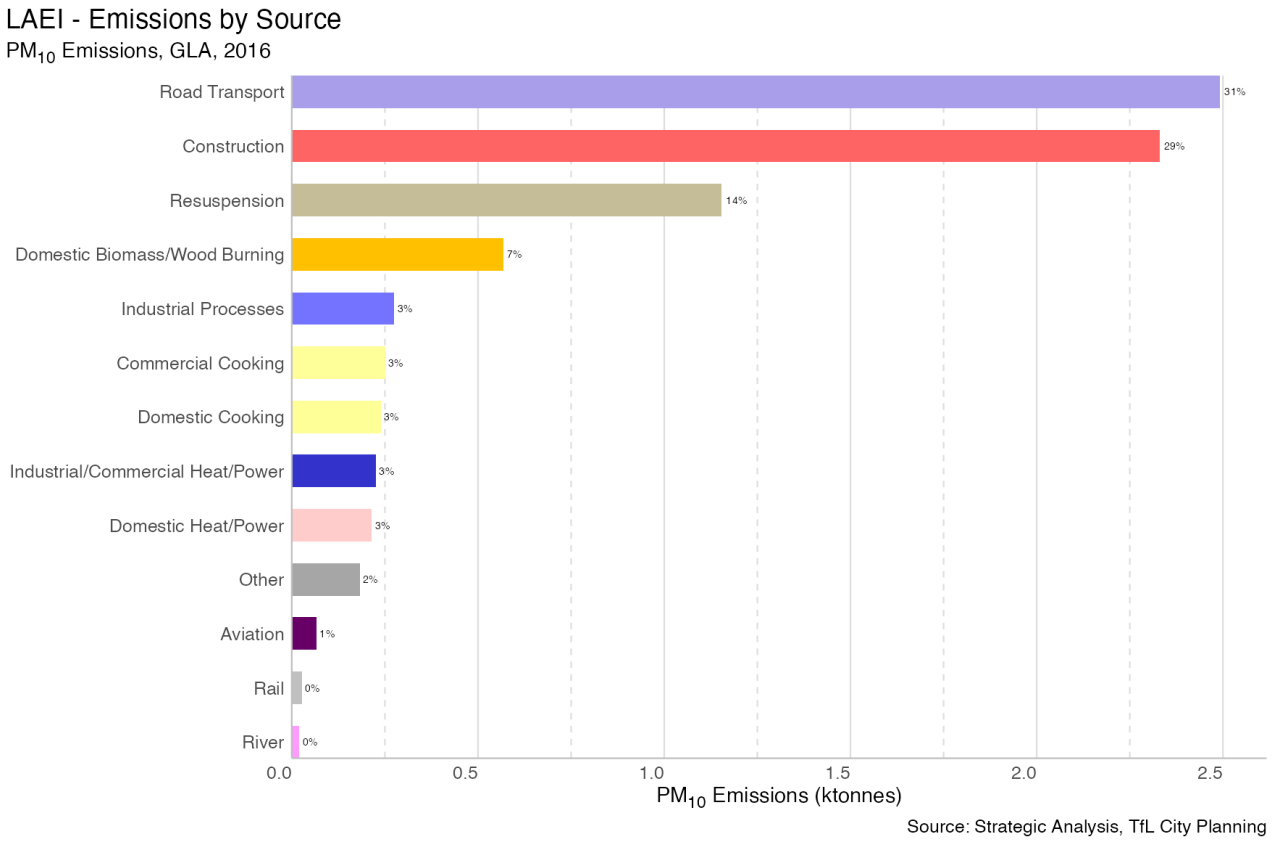


Figure 13 - 2019 PM_{10} Emissions by Source in Greater London

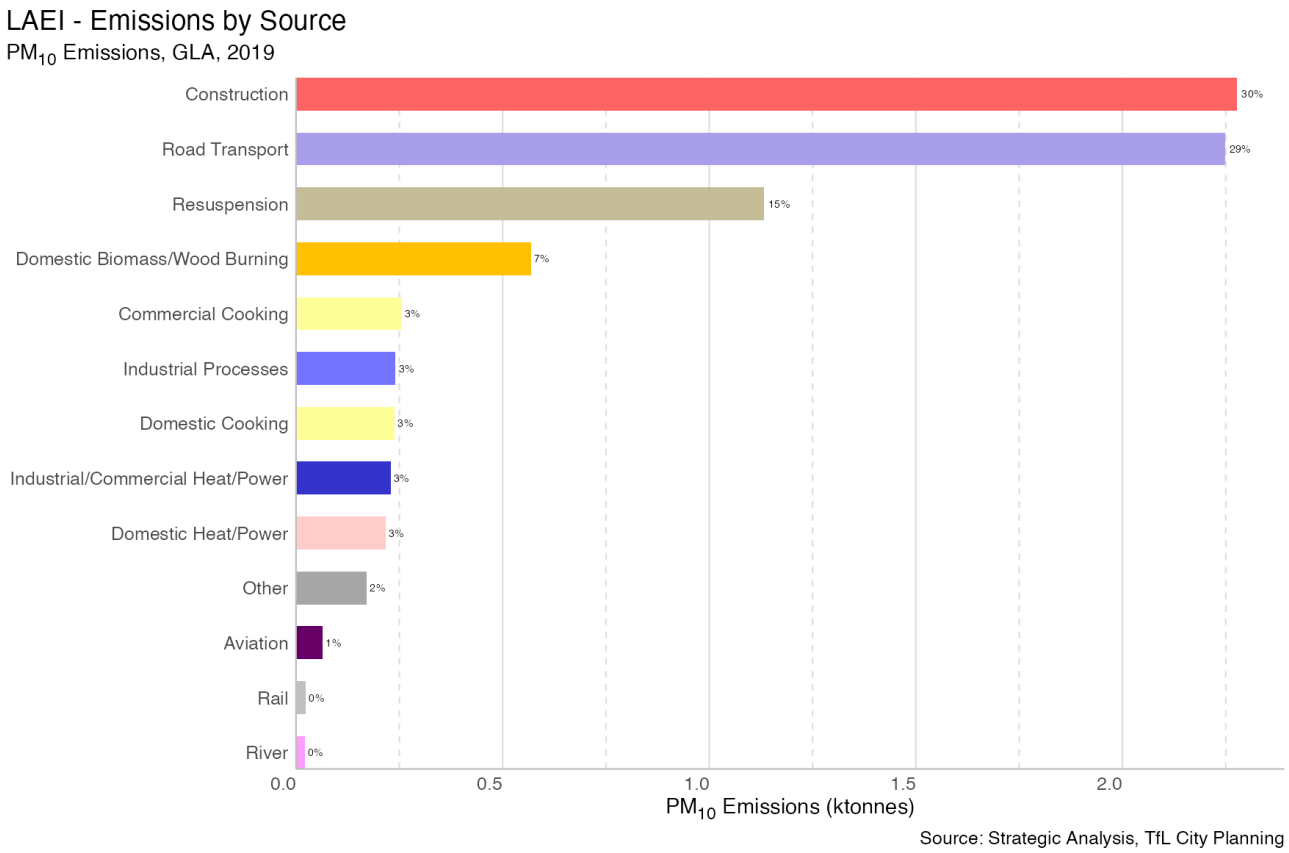


Figure 14 - 2022 PM_{10} Emissions by Source in Greater London

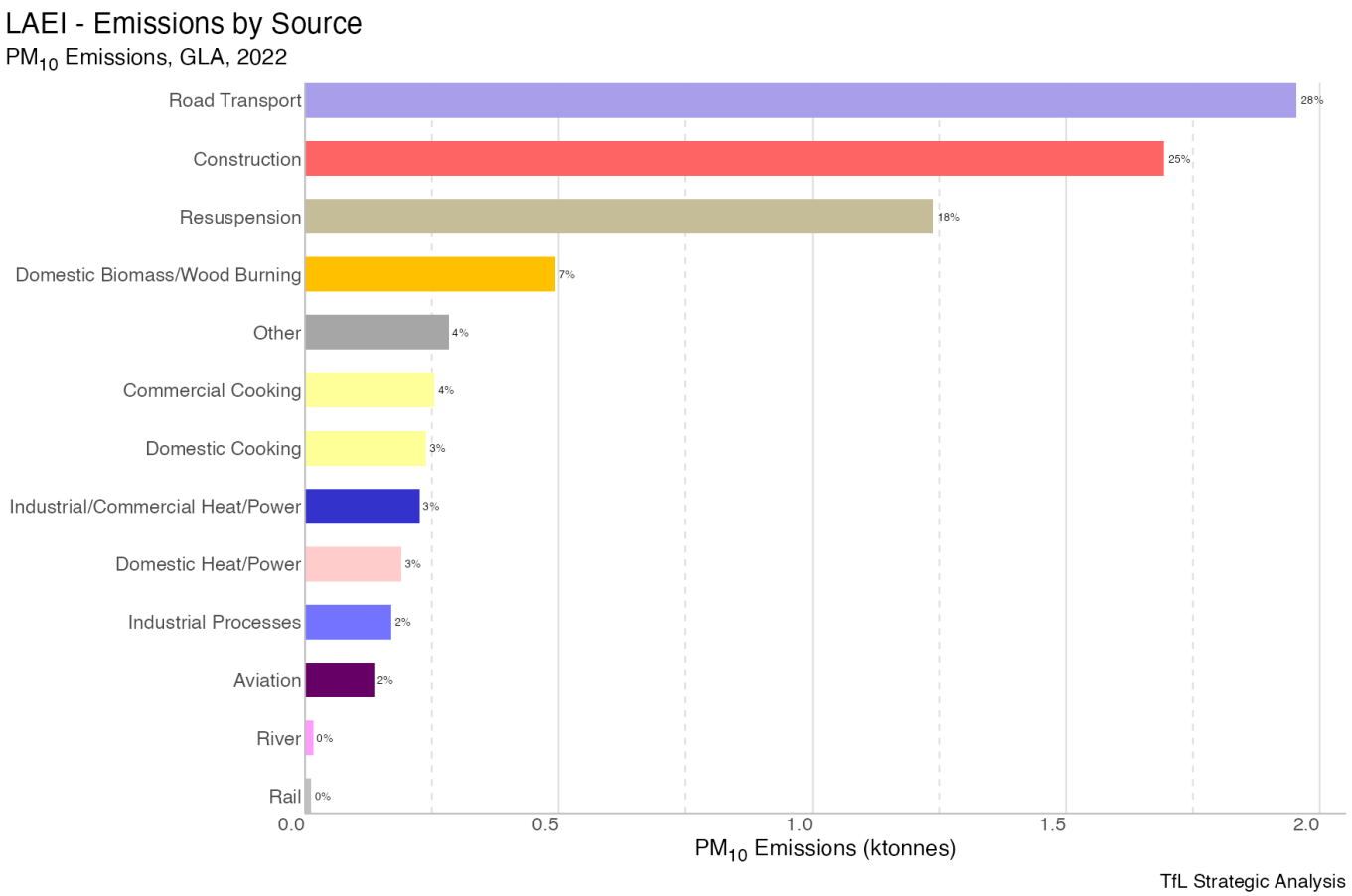
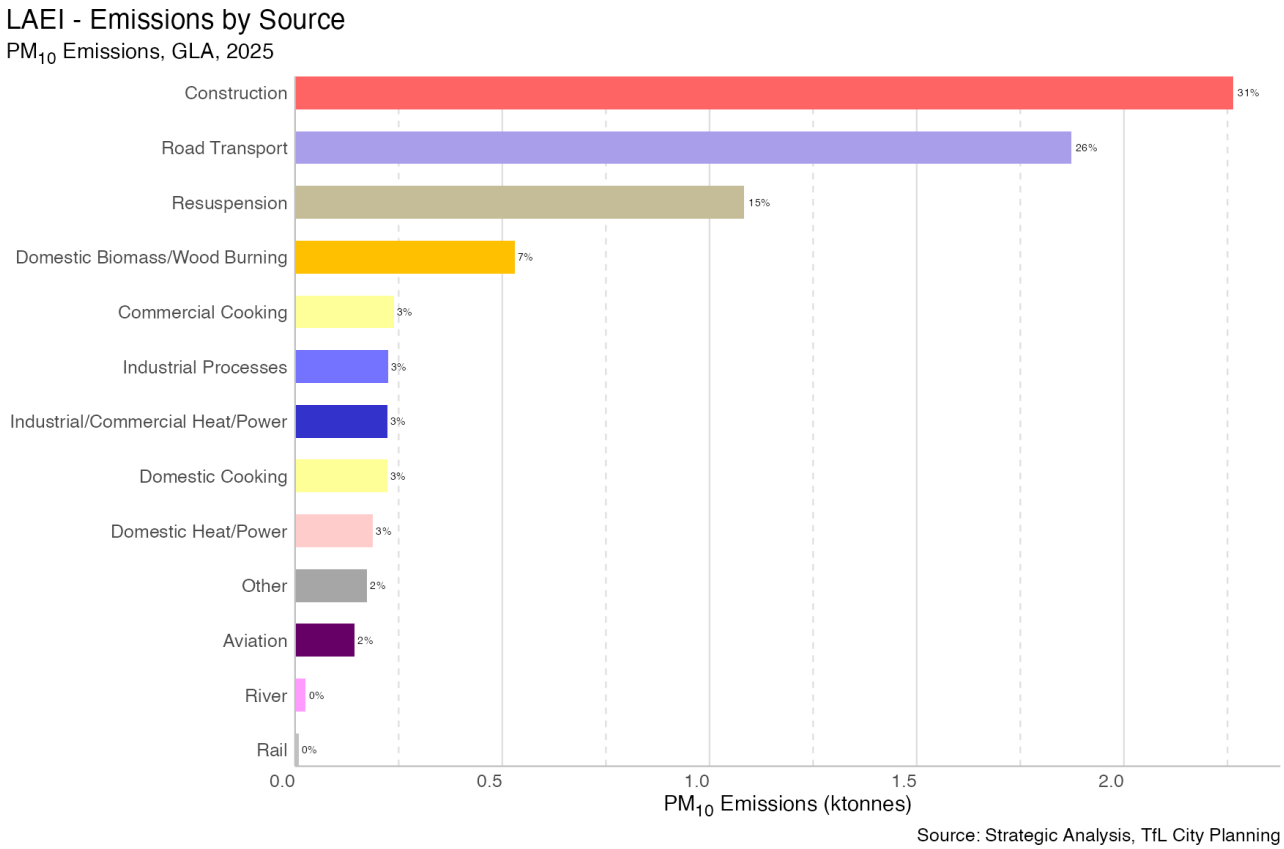
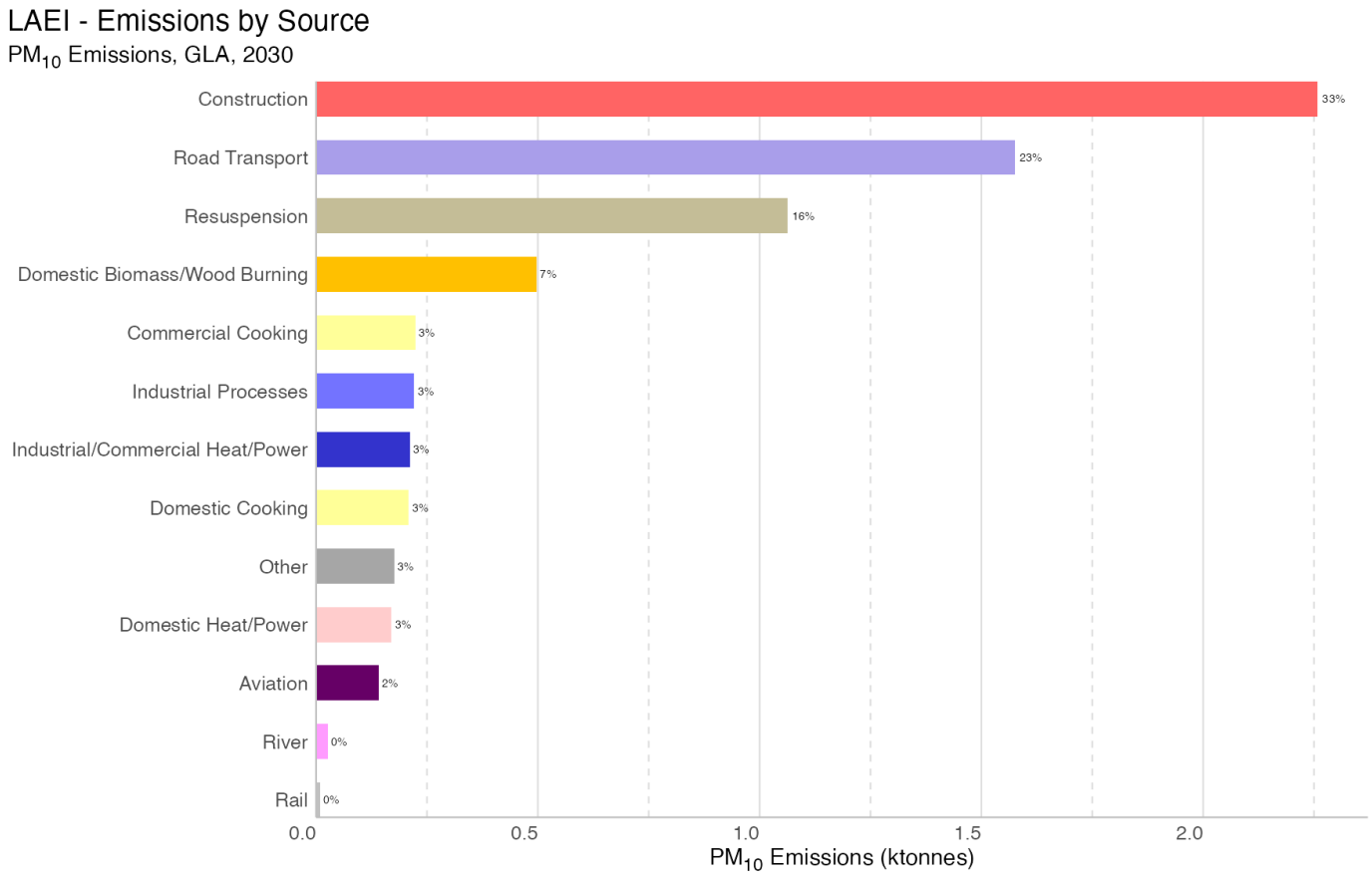


Figure 15 - 2025 PM_{10} Emissions by Source in Greater London



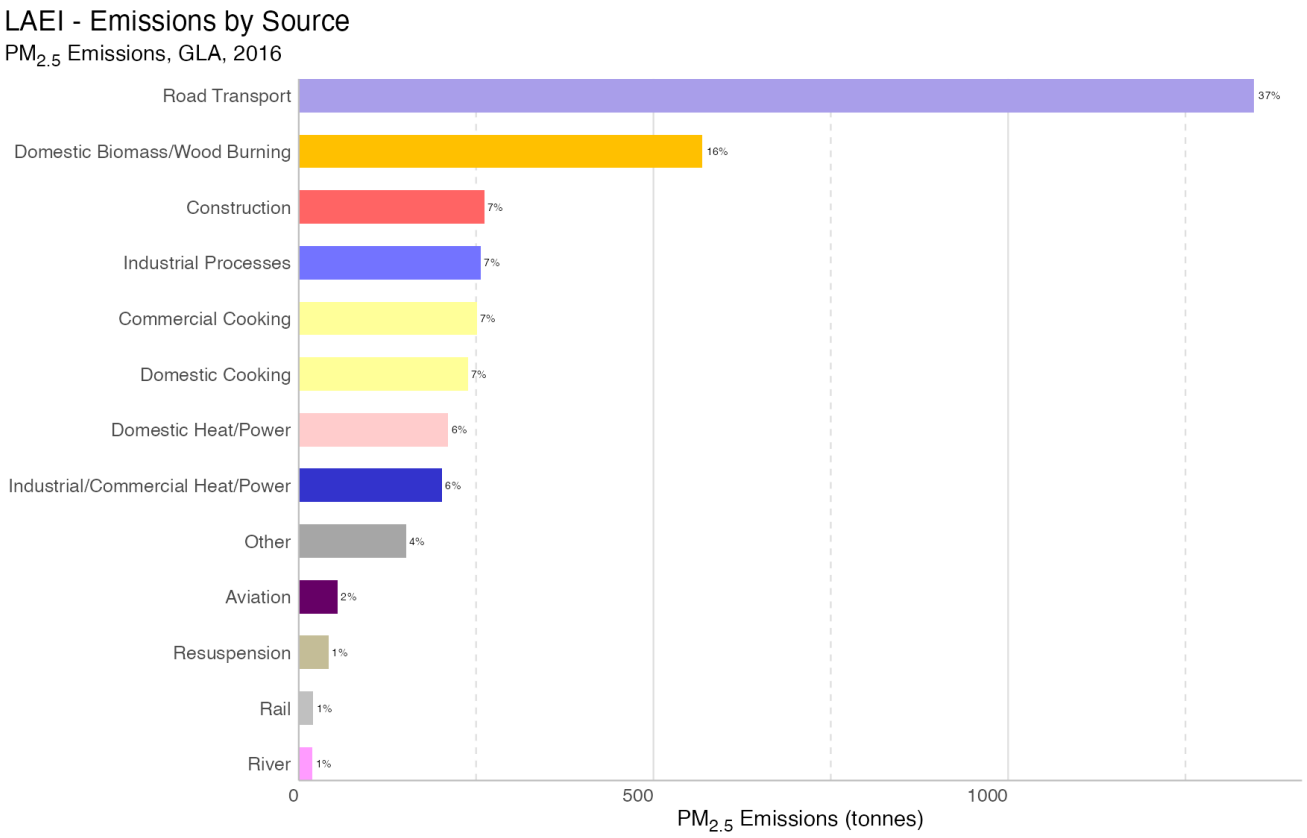
Source: Strategic Analysis, TfL City Planning

Figure 16 - 2030 PM_{10} Emissions by Source in Greater London



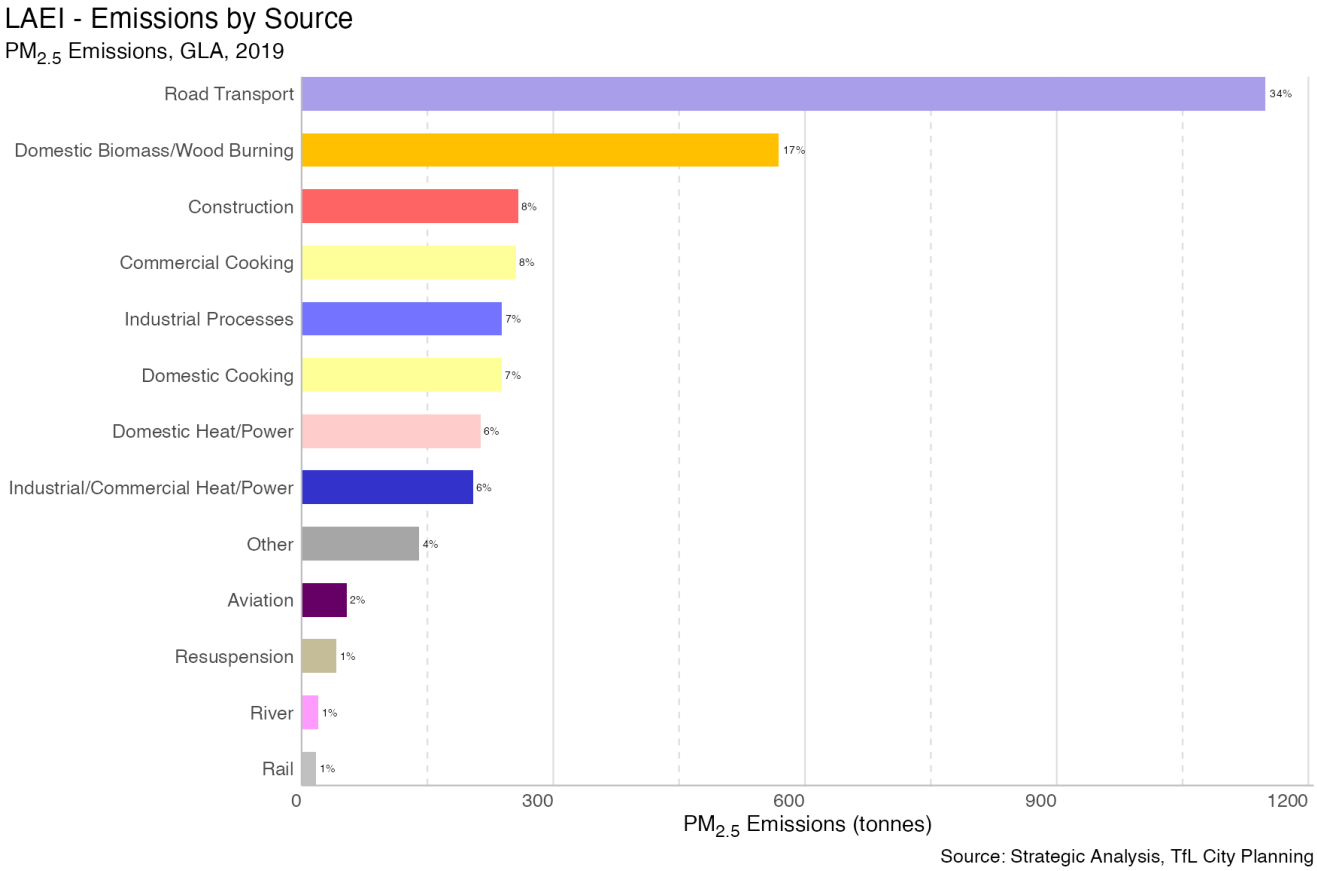
Source: Strategic Analysis, TfL City Planning

Figure 17 - 2016 $PM_{2.5}$ Emissions by Source in Greater London



Source: Strategic Analysis, TfL City Planning

Figure 18 - 2019 $PM_{2.5}$ Emissions by Source in Greater London



Source: Strategic Analysis, TfL City Planning

Figure 19 - 2022 $PM_{2.5}$ Emissions by Source in Greater London

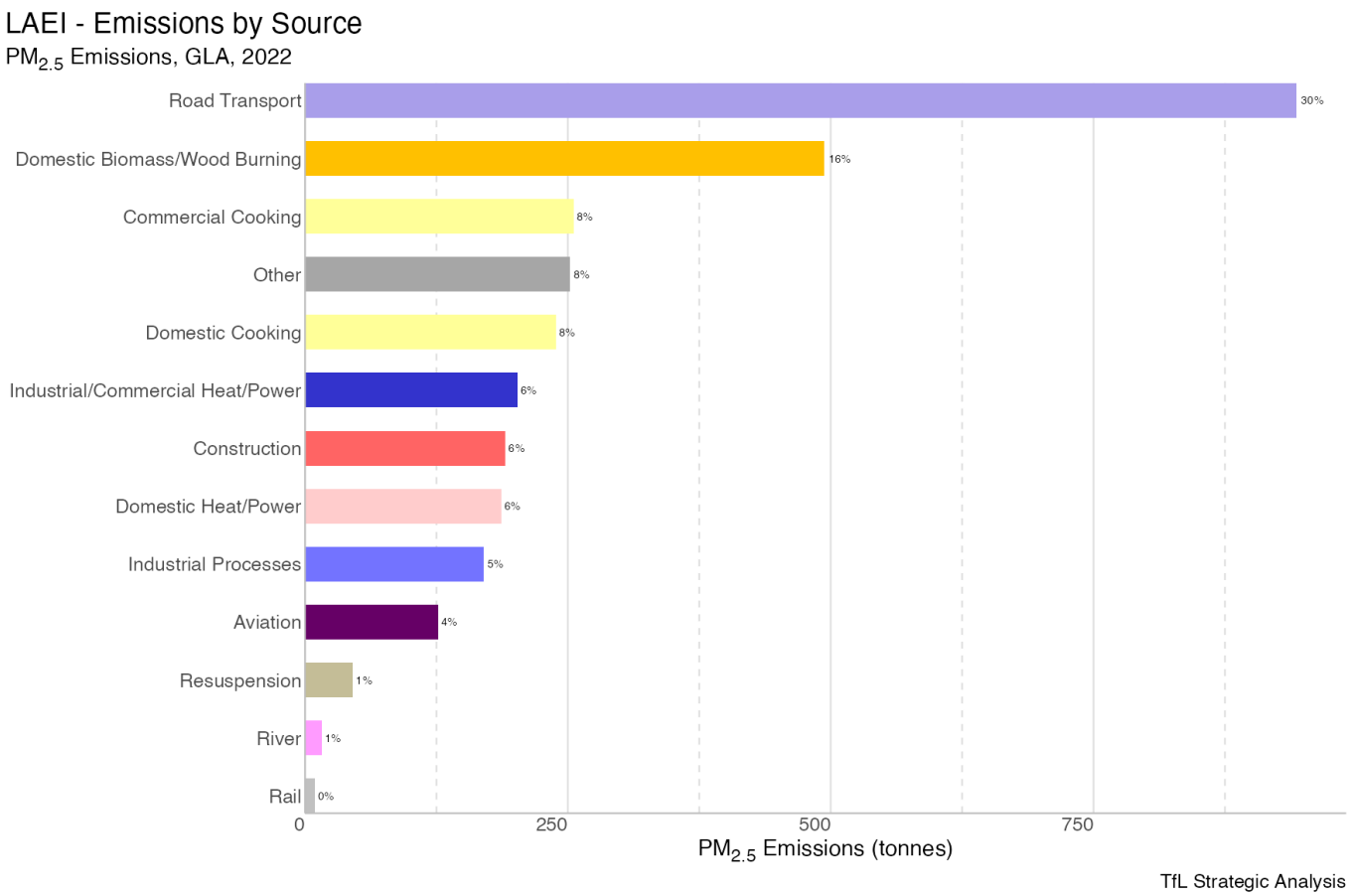


Figure 20 - 2025 $PM_{2.5}$ Emissions by Source in Greater London

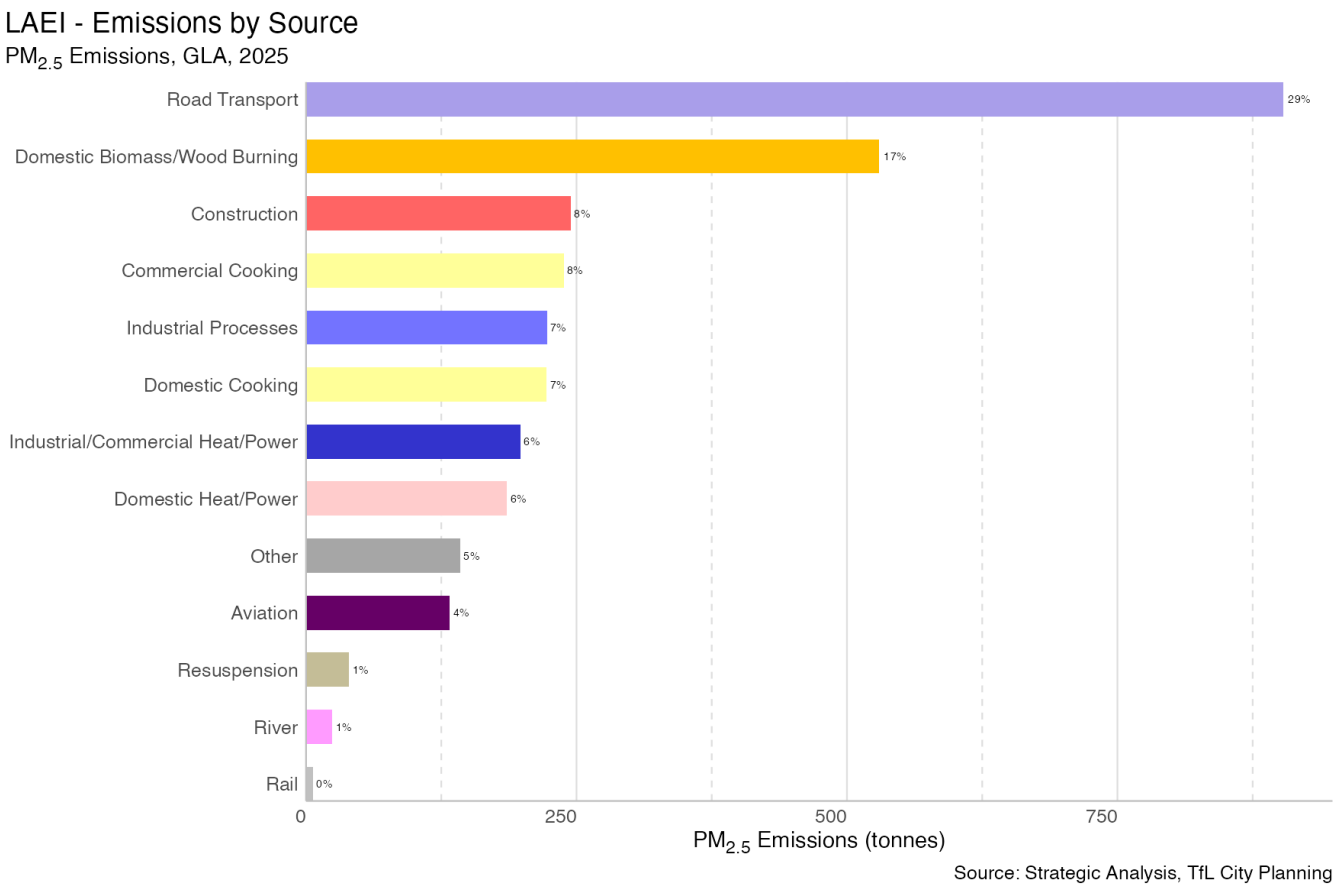


Figure 21 - 2030 $PM_{2.5}$ Emissions by Source in Greater London