Report

Local Transport Interventions to Achieve Limit Values and WHO Guidelines across Europe

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Executive Summary

A revised Ambient Air Quality Directive (AAQD) has recently been agreed which sets new limit values for concentrations of nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$). The World Health Organization (WHO) has issued air quality guidelines for NO_2 and $PM_{2.5}$ which are set at half the new limit values. Modelling work undertaken on behalf of the European Commission, which provides an evidence base for the AAQD, did not consider the impact that local measures could have on limit value compliance. However, city administrations have a key role to play in delivering better air quality, and mobility policies are likely to be central to reducing concentrations of NO_2 and $PM_{2.5}$.

This report describes interventions to local road transport which could unlock the ability to achieve the new air quality limit values and WHO guidelines for NO_2 and $PM_{2.5}$. The interventions include replacing older vehicles with those meeting the latest European type approval emissions standards, accelerating the uptake of electric vehicles, modal shift away from private vehicles, and combinations of these approaches. The study has assessed how altering the future vehicle fleet can achieve reduced future concentrations. It has relied on roadside NO_2 and $PM_{2.5}$ measurements reported to the European Environment Agency, published trajectories for wider-scale background concentrations, and forecasts of future vehicle fleet compositions and their associated emissions. it has assessed conditions in 2030 and 2040 at worst-case locations in:

- Paris;
- Milan; and
- Warsaw.

In addition, measurements from across Europe have been used to characterise worst-case roadside air quality in 'typical' cities within:

- Western Europe; and
- Eastern Europe.

A variety of measures are available to reduce the effects of local road traffic on concentrations of NO_2 and $PM_{2.5}$. This report has shown how the targeted application of packages of measures will allow significantly improved air quality at worst-case roadside locations. This, in turn, will allow the earlier attainment of limit values and WHO guidelines than would otherwise be possible.

Table 1 summarises the air quality standards which could be achieved in each city and in each year using the measures set out in this report. The precise package of transport measures differs for each city and depends on the desired outcome with respect to targeting limit values or WHO guidelines in a given year. In some cases, the limit values are already predicted to be achieved without any additional local traffic interventions, but local actions would allow them to be achieved sooner. The WHO guidelines will not be achieved without targeted local measures. In some cases, local action on road transport would need to be combined with improvements to other sectors and, in some instances, meeting the WHO guidelines would require a greater level of ambition, across a broader range of sectors, than it has been possible to quantify in this report. However, even here, the measures outlined could deliver significantly improved air quality.

This report has only considered in detail actions to reduce emissions from road transport, but has shown how interventions to local transport policy can bring about significantly improved local air quality and play an important part in achieving both the limit values and WHO guidelines. In particular, the results for the ‘typical’ cities indicate how all cities across Europe could harness the benefits of transport policies to improve local air quality and facilitate compliance with both the AAQD limit values and WHO guidelines.

Table 1: Summary of Air Quality Standards Which Can be Achieved by City and by Year

Pollutant	NO_2		$PM_{2.5}$	
Concentration standard	**20**	**10**	**10**	**5**
2030				
Paris	✅	🔨	😇	🔨
Milan	✅	🔨	🔨	😠
Warsaw	✅	😠	✅	😠
Typical Western European City	😇	✅	😇	🔨
Typical Eastern European City	✅	🔨	🔨	😠
2040				
Paris	😇	✅	😇	🔨
Milan	😇	✅	🔨	😠
Warsaw	✅	🔨	✅	🔨
Typical Western European City	😇	✅	😇	🔨
Typical Eastern European City	😇	✅	🔨	😠

- The air quality standard is already forecast to be achieved without any local traffic interventions. 😇
- The air quality standard could be achieved using the local transport measures presented in this report. ✅
- The air quality standard could be achieved by combining the packages of local transport measures presented in this report with achievable reductions from other sectors. 🔨
- Achieving this standard would require greater ambition, across a broader range of sectors, than it has been possible to quantify in this report. 😠

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Abbreviations

AAQD	Ambient Air Quality Directive
AQC	Air Quality Consultants Ltd. part of Logika Group
AQEG	UK Government's Air Quality Expert Group
BEV	Battery Electric Vehicle
CCC	Clean Cities Campaign
CLRTAP	Convention on Long-range Transboundary Air Pollution
CNG	Compressed Natural Gas
COPERT	COmputer Programme to calculate Emissions from Road Transport
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Programme
Euro Standards	European type approval emissions standards
EUTRM	European Transportation Roadmap Model
EV	Electric Vehicle
HGV	Heavy Goods Vehicle
ICE	Internal Combustion Engine
Kph	kilometres per hour
L-cat	L-category vehicles. Light powered vehicles including motorcycles, tricycles and quadricycles
LPG	Liquid Petroleum Gas
MSC-W	Meteorological Synthesizing Centre – West
NO$_2$	Nitrogen dioxide
NOx	Nitrogen Oxides (NOx is the sum of NO$_2$ and nitric oxide ('NO')
NRMM	Non Road Mobile Machinery
PHEV	Plugin Hybrid Electric Vehicle

$PM_{2.5}$	Fine particulate matter with an aerodynamic diameter smaller than 2.5 micrometres
T&E	Transport and Environment
WAM	With Additional Measures
WHO	World Health Organization
ZEEV	Zero Exhaust Emission Vehicle

1 Introduction

Background

1.1 A revised Ambient Air Quality Directive (AAQD) has recently been agreed[1] which sets new limit values for concentrations of nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$)[2]. Separate to this, in 2021 the World Health Organization (WHO) issued new air quality guidelines[3] which also covered NO_2 and $PM_{2.5}$.

1.2 The new limit values will have specific legal standing. When the revised AAQD comes into force, Member States will need to set out plans for how they are going to achieve compliance with the limit values and may be subject to legal proceedings if they are not ultimately met. The WHO guidelines do not have the same standing; they provide an evidence base which can be used, alongside consideration of the practicability of achieving specific future concentrations, to set new air quality standards. The new limit values and 2021 WHO guidelines which are relevant to this assessment are summarised in Table 2.

Table 2: AAQD Limit Values and WHO Guidelines Considered in this Report

Pollutant	Pollutant	Value (μg/m³)
New AAQD limit values	Annual Mean NO_2	20
	Annual Mean $PM_{2.5}$	10
2021 WHO guidelines	Annual Mean NO_2	10
	Annual Mean $PM_{2.5}$	5

1.3 City administrations have a key role to play in supporting the achievement of cleaner air and, with road transport continuing to be a major source of both NO_2 and $PM_{2.5}$, mobility policies will be a central part of that effort. However, modelling work undertaken on behalf of the European Commission, to provide an evidence base for the AAQD, did not take into account the impact that local measures could have on limit value compliance. Previous work[4] has demonstrated the role that Low and Zero Emission Zones could play in achieving compliance on an earlier timeframe than that proposed in the AAQD. This study builds on that work, expanding the range of policy interventions on transport at the city level and assessing whether such policies could support the achievement of cleaner air on an accelerated timescale. The work has been carried out by Air Quality Consultants Ltd (AQC), on behalf of Transport and Environment (T&E).

1.4 Limit value compliance must be achieved at all relevant locations within each member state, and the Court of Justice of the European Union has previously clarified that compliance must be assessed at monitoring states where people's exposure is greatest, and not based on an average across an area[5]. Within each member state, the location with the maximum reported concentration thus defines if, and when, a limit value is achieved. Local 'hot spot' areas[6] inevitably dictate the

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[1] https://www.europarl.europa.eu/news/en/press-room/20240419IPR20587/air-pollution-parliament-adopts-revised-law-to-improve-air-quality

[2] Amongst other pollutants

[3] https://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf

[4] https://cleancitiescampaign.org/wp-content/uploads/2023/05/Quantifying-the-impact-of-low-and-zero-emission-zones-in-six-European-cities_final.pdf

[5] https://www.clientearth.org/latest/latest-updates/news/clean-air-closer-for-brussels-after-top-eu-court-ruling/

[6] Meeting specific siting requirements.

ultimate date of compliance. Measures to improve air quality in these worst-case locations usually combine actions across a range of spatial scales, but local actions can often be particularly effective to address these 'hot spots'.

1.5 The aim of the study has been to define alternative sets of transport interventions to unlock the ability to achieve future air quality standards which would otherwise be impossible, or much more challenging, to achieve.

1.6 This has been done for both 2030 and 2040 at worst-case locations in:

- Paris;
- Milan; and
- Warsaw.

1.7 In addition, measurements from across Europe have been used to characterise worst-case roadside air quality in 'typical' cities within:

- Western Europe; and
- Eastern Europe.

Approach

1.8 While a range of assessment methods might ultimately be required, the most common approach in reporting compliance with the limit values is to use measurements made at fixed monitoring sites. As noted above, the monitoring site[6] which measures the highest concentration ultimately dictates when, and if, the limit value is exceeded within a zone or agglomeration. This study has followed the same method used previously[4], of focusing on the fixed monitor within selected cities measuring the highest concentrations. However, since very local actions (e.g. individual road closures) could simply 'move' the worst-case measurement in a city, and because the existing fixed monitoring sites are unlikely to represent unique[7] air quality conditions within each city, the worst-case measurements are taken more broadly to represent worst-case air quality across the city as a whole. The potential future benefits on these concentrations from future transport interventions have then been quantified.

1.9 Future baseline predictions for the worst-case monitoring locations have been used to show which limit values and WHO guidelines are likely to be exceeded in 2030 and 2040, and which limit values and guidelines will be achieved without any additional local transport interventions. The future baseline predictions have also shown the reductions to local sources which would be needed for the limit values and guidelines to be achieved in 2030 and 2040. The WHO guidelines are set at half the levels of the limit values and are therefore much more challenging to meet. The extent of this challenge is, however, different in different cities. It is also different in different years; the WHO guidelines will be much more challenging to achieve in 2030 than in 2040.

1.10 This study has identified transport interventions which will allow the limit values and WHO guidelines to be achieved where that would not otherwise be the case, and has necessarily focused on those limit values and guidelines where achievement is most likely to be possible. For example, the 20 $\mu g/m^3$ limit value for NO_2 is predicted to be exceeded in Warsaw in 2030 without additional

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[7] or even the worst-case location. Locations with fixed monitors are unlikely to capture the worst air quality across all hotspots in a city (https://www.aqconsultants.co.uk/CMSPages/GetFile.aspx?guid=2b5163c4-a64a-482a-930a-d0d99ee52b84)

interventions and so the focus for Warsaw in 2030 has been to show how changes to the vehicle fleet would allow this limit value to be achieved. By contrast, in Paris in 2040, the 20 µg/m^3 limit value for NO_2 is predicted to be achieved without any additional local transport interventions and so the focus has been to show how changes to the vehicle fleet would allow the 10 µg/m^3 WHO guideline to be achieved.

Transport Interventions Considered

1.11 The intention of this study is not to provide a definitive and prescriptive roadmap to achieving the limit values and WHO guidelines. Instead, it is to illustrate that local action on road transport can allow more ambitious air quality targets, and/or timescales, to be met, and the types of interventions which can allow this to happen. It presents the future vehicle fleets which would achieve stated limit values and WHO guidelines in each real and 'typical' city, but does not seek to develop the policies which would be needed to deliver these interventions.

1.12 In practice, the same outcome with respect to traffic-related air quality might be achieved in any number of alternative ways. For example, a 10% reduction in NO_2 from cars could, very broadly, be achieved by reducing car numbers by 10%, by switching 10% of the car fleet to electric vehicles ('EVs'), or by upgrading older vehicles to the latest European type-approval emissions standards ('Euro standards'). Because of this, the approach taken here has been to present four alternative illustrative packages of transport interventions. These have been called:

- **'ICE Update'** – this package illustrates what could be achieved by focusing on upgrading the Internal Combustion Engine ('ICE') fleet to the latest Euro standards. It does not rely on any additional uptake of EVs over that assumed in the future baseline scenarios and does not rely on traffic reduction measures or modal shift;

- **'Accelerated EV'** – this package focuses on upgrading the fleet to EVs. In most cases it does not rely on upgrading vehicles to alternative Euro standards (beyond that assumed in the future baseline) and does not rely on traffic reduction measures or modal shift;

- **'Alternative Modes'** – this package focuses on reducing trips made in passenger cars and vans. For passenger cars, trips are transferred to car share, active and public transport, and to a set of vehicles collectively described as 'electric light mobility'. For this report, 'electric light mobility' refers to any alternative to traditional cars and vans which has an electric motor (and is therefore distinct from 'active travel' although there can often be cross-over). It includes, for example, electric bicycles, scooters, mopeds, cargo bikes, rickshaws and micro-cars[8];

- **'Going Further'** – the analysis has shown that each of the above packages of measures can, on its own, bring about large improvements to local air quality and deliver attainment of air quality standards which would otherwise not be possible. 'Going Further' combines the measures from all of these and shows how it would be possible to drive even larger air quality improvements and meet more challenging air quality standards. In many cases, the 'Going Further' package of measures can achieve larger improvements to concentrations with smaller changes to the existing vehicle fleet, since it draws from all available transport strategies.

1.13 While the focus of the 'ICE Update', 'Accelerated EV' and 'Alternative Modes' scenarios has been on those specific areas, they have not been constrained to only apply these measures where this would make large air quality improvements unfeasible; for example 'Alternative Modes' relies on some upgrading of older HGVs to current Euro standards.

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[8] In terms of the predictions made in this report, the difference between active travel and electric light mobility is the consideration of emissions from brake, tyre and road wear.

1.14 The ‘Alternative Modes’ and ‘Going Further’ intervention packages both rely on a reduction in trips made by cars and vans. In both cases, it has been assumed that trip demand remains constant and so the same journeys are made using alternative modes. In practice, trip reduction might equally be delivered by reducing trip demand (for example through better delivery logistics or home working infrastructure). It has not been possible to quantify this within the current study, but demand reduction provides an additional tool to city administrations which could help to deliver the benefits predicted in this report.

2 Methodology

2.1 The approach to this study draws on that of previous work[4]. For ease of understanding, the approach is described here in full.

Conceptual Overview

2.2 Air quality modelling can often be complex, combining multiple threads of highly detailed assumptions. The relative uncertainty around different assumptions is not always the same and it is not always obvious that the additional complexity gives more accurate results.

2.3 The approach taken here seeks to cut through much of the complexity often associated with predictive air quality modelling. It forecasts ambient concentrations without recourse to dispersion algorithms or multi-source emissions inventories. It uses recent measured concentrations, combined with the relative changes to predicted future transport emissions and background concentrations, to estimate future ambient concentrations. While such a simplified approach does have clear limitations, which are identified in Paragraphs 2.35 to 2.42 and are intended to be fully transparent, the outcomes are suitable to demonstrate the effects that local traffic interventions might have on worst-case concentrations within a city. While more complex modelling might add detail, it would not necessarily result in more accurate future-year predictions or change the outcomes of this study.

2.4 The approach taken can be summarised as:

- Define the road increment to measured annual mean NO_2 and $PM_{2.5}$ concentrations - in most cases this is taken as the maximum measured concentration minus the measured concentration from a representative local background monitoring site;
- Predict the change in traffic-related nitrogen oxides (NOx) and $PM_{2.5}$ emissions within each area, over time and associated with each transport intervention - this was done using a simple emissions model, with fleet projections derived with assistance of T&E;
- Predict the change in background concentrations over time – this was done by referring to the European Monitoring and Evaluation Programme ('EMEP') Meteorological Synthesizing Centre – West ('MSC-W') model[9] calculations made for the Convention on Long-range Transboundary Air Pollution (CLRTAP)[10] during the review of the Gothenburg protocol in 2021-2023[11] (hereafter referred to as the 'EMEP model'), alongside, in some cases, additional more speculative improvements to non-transport emissions; and
- Assume that the relative change to local traffic-related NOx and $PM_{2.5}$ emissions will translate directly as a relative change to the local increment of NO_2 and $PM_{2.5}$ concentrations.

2.5 The approach taken here does not require, or define, a specific geographical extent of any of the transport interventions. It simply assumes that the intervention will act on the entire local traffic increment to concentrations. In practice, this is usually dominated by roads within 200 m of an assessment point, but while the assessment points are based on the fixed monitoring sites, they are not intended to solely represent these locations. The principal limitations with this approach are that it assumes direct linear relationships between total traffic emissions within each area and those which drive concentrations at each monitor, and between NOx and NO_2 concentrations. The implications of these, and other limitations, are discussed further in Paragraphs 2.35 to 2.42, but

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[9] https://www.emep.int/mscw/
[10] https://unece.org/environmental-policy-1/air
[11] https://unece.org/media/press/386648

notwithstanding these limitations, the approach is sufficient to indicate the potential benefits achievable within a city.

2.6 Further details of the approach are provided in the next subsections.

Defining Existing Baseline Local Road Increments

2.7 As explained in Paragraph 2.3, this study cuts through model complexity by relying on ambient measurements. The base year for the study was defined as 2023, which is the most recent full calendar year for which measurements were available.

2.8 For Paris, Milan and Warsaw, the fixed roadside monitoring site with the highest measured annual mean NO_2 concentration in 2023 was identified. The nearest representative background monitor was also identified. The difference between the concentrations measured at the roadside and background was taken to represent the local road increment. Further details of this process, and a description of the measurements used, is provided in Appendix A1.

2.9 The same approach was taken for $PM_{2.5}$ where suitable data existed. However, in some cases, direct reliance on the reported measurements was not considered to be the most appropriate approach (see Appendix A1). This was because either the available roadside measurements were not considered to represent a worst-case location within the city, or because the available background measurements did not appear to sufficiently represent the contribution from other sources at the roadside monitoring site. Because of these limitations in the available monitoring, for Warsaw, local road-$PM_{2.5}$ was calculated from measured road-NOx concentrations, while for Milan it was calculated from measured road-NO_2 concentrations. Details of this approach are given in Appendix A1.

2.10 To calculate road increments in 'typical' Western and Eastern European cities, the approach has been to collate the 2023 measurements from all roadside and background NO_2 and $PM_{2.5}$ monitors across Europe for which data are reported to the European Environment Agency (EEA). A geographical analysis was then carried out to identify those roadside monitors with a nearby representative background monitor. For each roadside site with a suitably paired background monitor, the local road increment to concentrations was derived by subtracting the measured background from the roadside total. The 'typical' roadside increment was then taken as the 75th centile across all of these results. Further details are given in Appendix A1.

Defining the Contribution from Other Sources

2.11 For Paris, Milan and Warsaw, the contribution to concentrations from all other sources in the 2023 baseline was taken from the background measurements and existing background calculations described above in Paragraphs 2.8 and 2.9. For the 'typical' Western and Eastern European cities, the approach was to take the average background concentration measured at each of the paired background monitors described in Paragraph 2.10.

2.12 Background concentrations in the future were predicted using the EMEP model. The predicted baseline concentrations in 2015, 2030, and 2050 in each EMEP grid square[12] which contains a relevant background monitor were determined from the Norwegian Meteorological Institute's data portal[13]. It was then assumed that the 2023 measured background concentrations will reduce at the same relative rate as the EMEP gridded predictions (assuming a linear trajectory between each EMEP modelled year).

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[12] The grid resolution of the EMEP modelling is approximately 10 km x 10 km.

[13] thredds.met.no/thredds/catalog/data/EMEP/2022GP_review_scenarios/catalog.html

2.13 For Paris, Milan and Warsaw, background concentrations were assumed to reduce at the rate predicted in the EMEP modelling for each specific location. For the 'typical' Western and Eastern European cities, the above EMEP predictions relevant to the location of each roadside-paired background monitor were used. Thus, each measured background concentration was forecast to 2030 and 2040 independently. The 'typical' background value was then taken as the mean of those future predictions. Further details are given in Appendix A1.

Additional Measures

2.14 In some cases, the future background concentrations on their own are predicted to exceed the most relevant limit values or WHO guidelines, meaning that even the complete removal of all local transport emissions could still not deliver their achievement. However, as explained above, the evolution of the background concentrations follows a baseline trajectory without any additional national-scale measures. Furthermore, it is not unreasonable to expect that there could be additional local initiatives to reduce emissions from local non-transport sources over the period to 2040.

2.15 To better demonstrate the positive effect that local-scale transport interventions might have on attainment of future limit values and guidelines, speculative removals from the 'background' concentration component have been considered. These have been termed "With Additional Measures" ('WAM') reductions but are not intended to align with any official emissions inventory reporting. Explicit suggestions regarding the precise non-transport interventions are not made, since they are not the focus of this study. The values which have been assigned to WAM reductions are wholly speculative; they are intended simply to illustrate what could be achieved if local transport measures worked in combination with actions to address emissions from other sources. The WAM values are, therefore, different in each city and in each year. They were defined taking account of the difference between the with-interventions totals and the relevant air quality standards. While the values assigned to the WAM reductions affect the presentation of the results, they do not affect the calculated emissions from road transport which are the focus of this study.

2.16 In the case of the 'typical' Western and Eastern European cities, Figure A1-17 and Figure A1-21 in Appendix A1 show that there is substantial variability in the trajectory of future predicted background concentrations based on the EMEP baseline modelling. In the context of this variability, the WAM reductions do not appear to be unreasonable. WAM reductions have not been suggested in all cases since it remains preferable to show how transport interventions alone could deliver attainment of a future air quality standard. The WAM reductions which have been tested are set out in Table 3.

Table 3: Reductions to the Background Components of Concentrations in the WAM Scenarios (µg/m^3)

Pollutant	Time Period	NO_2	$PM_{2.5}$
Greater Paris	2030	4	4
	2040	n/a	3.25
Milan	2030	3	3.5
	2040	n/a	1.5
Warsaw	2030	n/a	n/a
	2040	3	4
'Typical' Western European City	2030	2.5	3.25
	2040	2	2.5
'Typical' Eastern European City	2030	3	2.5
	2040	n/a	1.8

2.17 How the WAM reductions in Table 3 might best be achieved will depend on the location and, in many cases, the political climate. In some locations, primary $PM_{2.5}$ emissions from commercial cooking alone are thought to contribute more than 5 µg/m^3 to annual mean $PM_{2.5}$ concentrations[14] and so action on this source might readily deliver the required WAM reductions. Emissions from domestic and commercial combustion can also be significant, and, in some locations, emissions from river transport are important. Non-road mobile machinery (NRMM) can be another significant source of primary $PM_{2.5}$. Emissions from NRMM can often be reduced significantly by using more modern conventional equipment and, by 2040, it seems likely that zero-exhaust (e.g. battery or hydrogen powered) NRMM will see more widespread use. At larger spatial scales, while the benefits associated with ammonia reduction are difficult to predict, reducing ammonia emissions from agriculture is likely to reduce the formation of secondary $PM_{2.5}$.

2.18 On balance, it is considered entirely possible to achieve reductions of at least the magnitudes shown Table 3. In practice, even more ambitious reductions may be possible, particularly in Eastern Europe and Milan where non-traffic $PM_{2.5}$ concentrations are predicted to be highest. It is not within the scope of this report to appraise the obstacles to different non-transport measures or to advise on the optimum approach to reduce $PM_{2.5}$ concentrations.

Predicting Local Road Increments in 2030 and 2040 Without New Transport Interventions

2.19 For each city, a local traffic emissions model has been generated, as described below.

Paris, Milan and Warsaw

2.20 For exhaust emissions, this has used the COPERT V5.7[15] hot emissions functions with an average speed of 30 kph. $PM_{2.5}$ emissions from road abrasion, tyre wear and brake wear have been

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[14] e.g. https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2019

[15] The COmputer Programme to calculate Emissions from Road Transport (COPERT) model is developed on behalf of the European Environment Agency. It predicts emissions from different types of vehicles principally based on average drive cycle speeds. It is used by member states

estimated using the Tier 2 approach in the 2024 update to the 2023 EMEP/EEA Emission Inventory Guidebook[16].

2.21 Emissions from resuspension of previously deposited material are not required to be reported in national inventories, since this would double-count national total emissions. No method is therefore provided in the Guidebook. Resuspension emission rates will vary by region, with the moisture content of air and road surface being important, as well as the use of road salts and winter tyres in some parts of Europe[17]. Resuspension is, however, efficient only for particles with a diameter greater than 1 μm, which limits its contribution to $PM_{2.5}$ concentrations[18]. Most studies which have quantified resuspension have thus focused on PM_{10} rather than $PM_{2.5}$[17]. The UK Air Quality Expert Group (AQEG)[18] used measurements made in London to show that the contribution of resuspension was mostly in the coarse ($PM_{2.5}$-PM_{10}) fraction of concentrations. The same report also combined modelling and measurements to source-apportion $PM_{2.5}$ and PM_{10} concentrations at monitoring sites across London, using the assumption that resuspension contributed significantly to PM_{10} concentrations but contributed nothing to $PM_{2.5}$. The current study has not, therefore, included emissions from resuspension. This may mean that the contributions from other sources will effectively have been over-predicted to compensate for the absence of a resuspension emissions source, but the extent of this is expected to be very small, with no significant implications on the study conclusions.

2.22 The fleet composition in 2023 has been predicted by combining country-specific fleet composition forecasts for 2024 provided by T&E, with national urban average fleet composition for each country in 2018 provided by emisia[19] for previous work. For Warsaw, these data were supplemented with local surveys carried out in 2020 by Lee et al., 2022[20] and provided by those authors. The baseline evolution of the vehicle fleet between 2023 and 2030 and 2040 was predicted using forecasts provided by T&E, supplemented where necessary with AQC's in-house fleet-turnover model.

2.23 The principal assumptions made in deriving the current and future fleet baseline fleet forecasts were:

- the relative proportions of cars, vans, HGVs, buses, and motorcycles (i.e. each of these broad categories as a proportion of total vehicles) and their size distributions (e.g. HGV weight) were taken from the national urban estimates for 2018 provided by emisia and assumed not to change over time;
- the composition of the passenger car fleet, including BEV and PHEV proportions and ICE Euro standards were assigned from national-level estimates provided by T&E from its European Transportation Roadmap Model (EUTRM)[21]. This covers 2030 and 2040. The earliest year in these data is 2024. The 2024 values have been applied to 2023 without adjustment.
- the proportion of Zero Exhaust Emission Vehicle ('ZEEV') vans in each city in 2030 was provided by the Clean Cities Campaign ('CCC') and T&E for previous work. The proportion of ZEEV vans in 2023 was scaled from the 2030 values based on the relative growth rates in aggregated (not country-specific) ZEEV van stock projections provided by T&E from EUTRM[21]. The relative

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across Europe for reporting their emissions to the European Commission, as well as for many local-scale applications which require the prediction of traffic emissions. https://copert.emisia.com/

[16] https://www.eea.europa.eu/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view

[17] https://www.sciencedirect.com/science/article/abs/pii/S1352231021004143

[18] https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1907101151_20190709_Non_Exhaust_Emissions_typeset_Final.pdf

[19] https://www.emisia.com/utilities/copert-data/

[20] https://theicct.org/wp-content/uploads/2022/04/true-warsaw-emissions-apr22.pdf

[21] https://www.transportenvironment.org/uploads/files/Clean-solutions-for-all-Report-1.pdf

increase in ZEEV vans between 2030 and 2040 was predicted to match that for BEV passenger cars for that city. For ICE vehicles, the proportion of each type of pre-Euro 6 ICE van was predicted to decline at 5% per year[22] from the 2018 emisia base data (i.e. 5% of the proportion in the previous year) to 2023[23], with those ICE vans not replaced by ZEEVs being replaced by Euro 6d vehicles. The same rule was applied to 2030 and 2040 but applied to all pre-Euro 6d vehicles after 2023.

- the proportion of ZEEV HGVs was based on aggregated (not country-specific) stock projections provided by T&E from EUTRM[21]. For ICE vehicles, the proportion of each type of pre-Euro VI HGV was predicted to decline at 5% per year[23] (i.e. 5% of the proportion in the previous year), with those ICE HGVs not replaced by ZEEVs being replaced by Euro VI vehicles.
- For L category vehicles, the proportion of each type of pre-Euro 5 vehicle was predicted to decline at 5% per year[23] from the emisia base data (i.e. 5% of the proportion in the previous year), with all vehicles replaced by Euro 5.
- The proportion of ZEEV buses in 2030 was provided by CCC and T&E for previous work (95% for all cities). The 95% value was assumed to remain unchanged in 2040. The proportion of ZEEV buses in each city in 2023 was estimated from predictions for 2025 derived during previous work. The composition of the remaining ICE fleet was spread between Euro IV to Euro VI in 2023 and assumed to be entirely Euro VI in 2030 and 2040.

2.24 Following advice from T&E, it was assumed that total traffic volumes in Paris and Milan would not increase between 2023 and 2040. For Warsaw, in the absence of city-level traffic forecasts, it was assumed that total car traffic volumes would increase at the same rate as total car traffic in Poland as forecast by T&E.

2.25 A summary of all current and future baseline vehicle fleet and growth assumptions is provided in Appendix A2.

2.26 These assumptions do not take explicit account of any planned or agreed local transport policies. Furthermore, there are appreciable limitations to using such high-level assumptions to represent individual cities and individual locations within those cities.

‘Typical’ Western and Eastern European Cities

2.27 The fleet composition in the ‘typical’ Western European city was defined by averaging the national urban proportions of cars, vans, HGVs, buses, and motorcycles and their size distributions across France, Spain, Italy and Belgium. These countries were used owing to data availability. The composition by fuel type and Euro standard was then taken as the average of that in Paris and Milan, which had already been calculated for the individual cities. For the ‘typical’ Eastern European city, the fleets were derived using the data for Warsaw described above. A summary of current and future baseline vehicle fleet and growth assumptions for the ‘typical’ cities is provided in Appendix A2.

Predicting Future Local Road Concentration Increments

2.28 The fleet data for each city (including ‘typical’ cities) and scenario described above were used in the emissions model to predict total emissions of NOx and $PM_{2.5}$, expressed per 100 vehicles

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[22] An analysis carried out for previous work showed that 5% removal aligns broadly with historical trends.

[23] subtracting one year to allow for an effect of the COVID Pandemic on vehicle use and sales.

(normalised to 2023[24]). The measured local road increments to concentrations were then scaled linearly based on these calculated emissions. For example, the measured local road increment to annual mean NO_2 concentrations in 2023 at the worst-case fixed monitoring site in Paris was 25.2 $\mu g/m^3$. The 2023 baseline NOx emissions in Paris were calculated as 50.6 g/km/100 vehicles. The 2030 baseline NOx emissions in Paris were calculated as 30.9 g/km/100 vehicles. The 2030 baseline local road increment to NO_2 concentrations was thus predicted to be $25.2 \times 30.9 / 50.6 = 15.4$ $\mu g/m^3$.

Calculating the Total Future Baseline Concentrations

2.29 For each future assessment year, the future local road increment has been added to the future increment from all other sources. This has been done separately for NO_2 and $PM_{2.5}$.

Developing the Transport Interventions

2.30 Using the model described above, the 2030 and 2040 baseline vehicle fleets have been incrementally adjusted until the predicted local road component of concentrations would be sufficiently low to meet the most relevant future air quality target[25] (see Paragraph 1.10). For the first three intervention packages described in Paragraph 1.12 ('ICE Update', 'Accelerated EV', and 'Alternative Modes') the aim has been to define pragmatic sets of changes which would cause a limit value or WHO guideline to be achieved without reliance on any WAM reductions (see Paragraph 2.15). For the 'Going Further' scenario, the aim has been to demonstrate the total reductions which could be achieved using a combination of these measures.

2.31 For Paris, Milan and Warsaw, the aim for the 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages has been to meet the most relevant target[25] as precisely as possible (i.e. without additional effort to go beyond that target). For the 'typical' cities, such precision is inappropriate, since future concentrations will occur within a relatively wide range. Rather than meeting the target precisely, the approach instead has been to demonstrate more broadly the benefits that different packages of measures could deliver.

2.32 Where passenger car trips are replaced with car share, or active travel and public transport, the relevant emissions have simply been removed from the model. No allowance has therefore been made for emissions from active travel, additional emissions from higher-occupancy cars, or any effect on emissions from public transport. Where passenger car trips are replaced with vehicles classified as 'electric light mobility', it has been assumed that each car would be replaced with a single vehicle which has the same non-exhaust $PM_{2.5}$ emissions as a 'Mini' ICE passenger car as defined in the EEA guidebook. In practice, for most of the vehicles which might be used as alternatives to passenger cars, this is likely to significantly over-state the vehicle weight and therefore emissions, making this approach conservative.

2.33 Where van trips are replaced with electric light mobility, it has been assumed that one van trip will be replaced with a single trip in a vehicle which has the same non-exhaust $PM_{2.5}$ emissions as a 'two-wheeled vehicle' as defined in the EEA guidebook. In practice, it is likely to take more trips in smaller vehicles to replace a single van. However, it is also likely that by using non-exhaust emissions which better represent motorcycles, the emissions from vehicles such as electrified cargo bikes will have been overstated. On balance, therefore, the approach is judged to be conservative.

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[24] This is to allow for traffic growth over the period 2023 to 2040.

[25] i.e. the target that can be met without reliance on WAM measures and which will still bring about significant improvements to local air quality. In practice, this is invariably the limit value or WHO guideline for NO_2.

2.34 As explained in Paragraph 1.11, this study has not designed the policies to deliver the packages of measures which have been developed. For example, a package of measures might include upgrading Euro 3 diesel cars to Euro 6, but does not seek to explain how this could be made to happen. Where it forms part of a package of measures, the modelling has assumed that all older vehicles can be upgraded or replaced with 100% effectiveness; no allowance has been made for any residual older vehicles in the fleet once those vehicles are targeted by a measure. The difference in NOx emissions between very old and very new vehicles can be extreme, and this means that the continued operation of even relatively small numbers of very old vehicles could significantly diminish the benefits of the measures which have been assessed. Significant care should, therefore, be employed when developing policies, particularly where exemptions to any locally-imposed vehicle emissions standards are being considered.

Limitations

2.35 This assessment has a number of limitations which may affect the overall results. An important limitation relates to an assumption that the local road concentration increment at the fixed monitoring site is apportioned directly in line with the city-average emissions profile. In practice this is unlikely to be correct. The concentration at each monitoring site will be driven mainly by emissions from those roads which are closest to it, and the precise fleet composition on these roads will often differ from the city average. For example, monitoring sites which are close to bus lanes are likely to have a stronger response to changes in bus emissions than this approach infers. However, each worst-case fixed monitor is not the only location in a city where air quality must improve. Furthermore, it is very often the case that similar concentrations could be measured elsewhere within a city if a new monitoring site were established there. The measured roadside concentrations are thus used to represent a more general position of worst-case elevated roadside levels across the city which might be affected by the transport intervention. The interventions have not been designed solely to target the single worst-case monitoring site.

2.36 Another implicit assumption is that the relationship between NO_2 and NOx is linear. This is also incorrect. Because the NO_2 to NOx relationship is curvilinear, a given percentage reduction in the local road NOx concentration increment will cause a smaller relative change in the local road NO_2 concentration increment. The precise relationship depends on local oxidant (including ozone) concentrations and on primary NO_2 proportions, both of which will change in the future. It has not been possible to include this level of detail in the study. Given the overall intention to broadly demonstrate the potential effects future transport interventions, the assumption of a linear NOx:NO_2 relationship is considered suitable.

2.37 A similar non-linearity appears in relation to vehicle-induced turbulence, whereby larger traffic volumes (and lower levels of congestion) cause more mixing of roadside air and therefore dilute roadside concentrations. This has not been considered in the current study.

2.38 The study also assumes that the transport interventions will not affect the contribution to concentrations from other sources. In practice, an element of the measured background concentrations will be caused by wider-scale traffic emissions and this would change as a result of the traffic interventions being assessed. Furthermore, reductions in NOx and ammonia from road traffic are also likely to reduce concentrations of secondary $PM_{2.5}$. It has not been possible to include this detail.

2.39 The fleet composition projections are relatively coarse and, as explained above, a more complex model would most likely give different future vehicle fleet composition projections. However, the simple assumptions used here are considered to be suitable for the current study.

2.40 There are also limitations associated with road traffic emissions factors used. In particular, uncertainty associated with non-exhaust $PM_{2.5}$ emissions factors is appreciable. As explained in Paragraphs 2.32 and 2.33, non-exhaust emissions from electric light mobility vehicles are likely, on balance, to have been overpredicted. This will mean that the benefits to $PM_{2.5}$ concentrations from the interventions which rely on these modes will have been understated.

2.41 It has been assumed that the improvements associated with Euro 6 and Euro VI are accurately predicted in COPERT V5.7 and that these will not be undermined by any use of 'defeat devices'.

2.42 COPERT V5.7 and the 2024 update to the EEA Guidebook do not include Euro 7 and so the assessment does not allow for the additional benefits, to both future baseline concentrations and associated with future interventions, which could be unlocked by Euro 7.

3 Results for Greater Paris

Current and Future Baseline Concentrations

3.1 Figure 3-1 summarises the predicted baseline concentrations at the worst-case monitoring site in Greater Paris. The background concentrations shown are those forecast directly from the baseline EMEP modelling for the Gothenburg Protocol revision and do not take account of any of the WAM reductions in Table 3.

3.2 Annual mean NO_2 concentrations are predicted to fall from 46.1 $\mu g/m^3$ in 2023 to 15.7 $\mu g/m^3$ in 2040. Most of this reduction is driven by forecast changes to the local vehicle fleet, but appreciable reductions to the 'background' component are also predicted, particularly between 2023 and 2030. The limit value of 20 $\mu g/m^3$ will be exceeded in 2030 but achieved in 2040. The WHO guideline of 10 $\mu g/m^3$ is predicted to be exceeded in each year. Of particular note, the 'background' component of concentrations is predicted to exceed 10 $\mu g/m^3$ in 2030, meaning that even the complete removal of all local transport emissions could not, on its own, achieve the WHO guideline in 2030. However, it is clear that targeted local transport measures, which could reduce the vehicle contributions to the concentrations shown in Figure 3-1, could nevertheless reduce concentrations in both 2030 and 2040.

3.3 Annual mean $PM_{2.5}$ concentrations are predicted to fall from 12.7 $\mu g/m^3$ in 2023 to 8.6 $\mu g/m^3$ in 2040. Most of this is driven by forecast changes to the 'background' component of concentrations, with only limited reductions to the concentrations arising from local traffic. This reflects the importance of non-exhaust emissions (principally brake, tyre and road wear) to local $PM_{2.5}$ concentrations and the fact that these emissions will continue to be important for modern and electric vehicles. The limit value of 10 $\mu g/m^3$ is predicted to be achieved by 2030, but the WHO target of 5 $\mu g/m^3$ will be exceeded in all years. The 'background' component of concentrations is predicted to exceed 5 $\mu g/m^3$ in both 2030 and 2040, meaning that even the complete removal of all local transport emissions could not, on its own, achieve the WHO standard in either year.

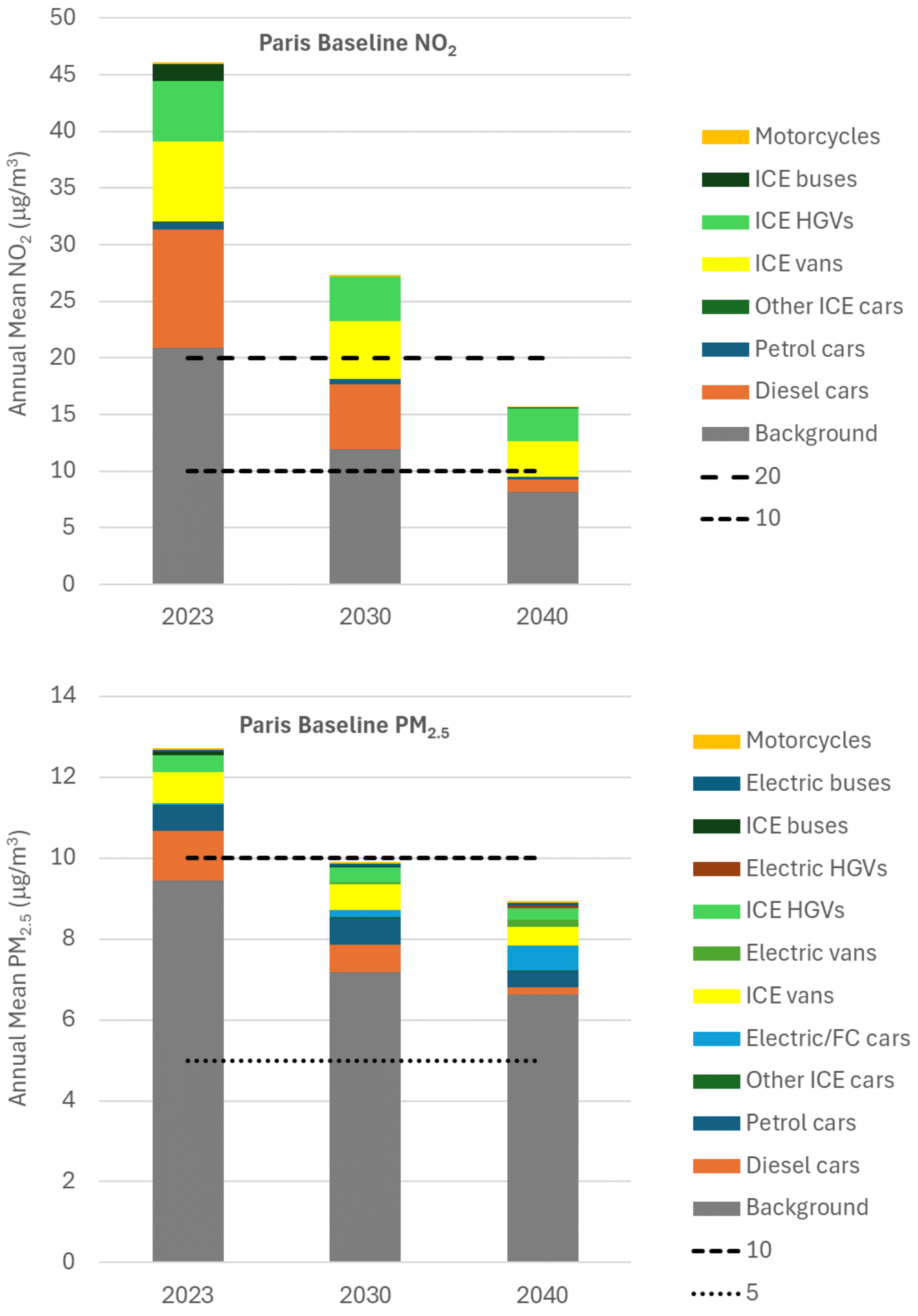


Figure 3-1: Current and Future Baseline NO_2 and $PM_{2.5}$ Concentrations at Worst-case Monitoring Location in Greater Paris in 2023, 2030 and 2040

Local Transport Interventions

2030

3.4 Table 4 summarises the local transport interventions which have been assessed for the four alternative intervention packages: 'ICE Update', 'Accelerated EV', 'Alternative Modes' and 'Going Further'. Figure 3-2 shows the effect that each of these packages of measures would have on the local road component of concentrations at the worst-case monitoring site in Greater Paris. It also shows (in a dashed line) the local road contributions below which the 20 $\mu g/m^3$ NO_2 limit value would be achieved (the 10 $\mu g/m^3$ $PM_{2.5}$ limit value is not shown since it is already predicted to be achieved in the 2030 baseline). Finally, it shows (in dash-dot lines) the local road contributions below which the 10 $\mu g/m^3$ (NO_2) and 5 $\mu g/m^3$ ($PM_{2.5}$) WHO guidelines would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered.

3.5 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions have all been designed to achieve the 20 $\mu g/m^3$ NO_2 limit value using alternative solutions. The 'Going Further' package of interventions shows what could be achieved using a combination of all available approaches. If the WAM reductions in Table 3 were also delivered, the 'Going Further' package would allow attainment not only of the limit values, but also of the WHO guidelines in 2030.

Table 4: Summary of Local Transport Interventions Assessed for Greater Paris in 2030

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 4 cars upgraded to Euro 6d. All Euro 4 diesel cars upgraded to Euro 6d. 60% of Euro 5 diesel cars upgraded to Euro 6d	20% of the non-EV car fleet upgraded to EV (all pre-Euro 5 cars, all Euro 5 diesel cars and 2% of Euro 6 a/b conventional diesel cars)	Focusing on older diesel cars, 24% reduction in total car trips (5% replaced with electric light mobility, 10% with car share, and 14% with active travel and public transport)	Focusing on older (pre-Euro 4) and particularly older diesel (pre-Euro 6d Temp) cars, 35% reduction in total car trips (10% replaced with electric light mobility, 10% with car share, and 15% with active travel and public transport)
Vans	All pre-Euro 4 vans upgraded to Euro 6d. All pre-Euro 6 diesel vans upgraded to Euro 6d	41% of the non-EV van fleet upgraded to EV (all pre-Euro 5 vans and all Euro 5 diesel vans)	Focusing on older vehicles 10% of van fleet replaced with electric light mobility	Focusing on older (pre-Euro 6 d-temp) vehicles, 24% of all vans upgraded to Euro 6d, 16% upgraded to EV, and 16% replaced with electric light mobility
HGVs	All pre-Euro V HGVs upgraded to Euro VI	No change	All pre-Euro IV HGVs upgraded to Euro VI	50% of all pre-Euro VI HGVs upgraded to Euro VI and 50% upgraded to EV
L-cat	No change	No change	No change to the baseline L-category fleet	All pre-Euro 3 L-category vehicles upgraded to Euro 3-5 (in proportion to baseline distribution)
Buses	No change	No change	No change	Fully electric

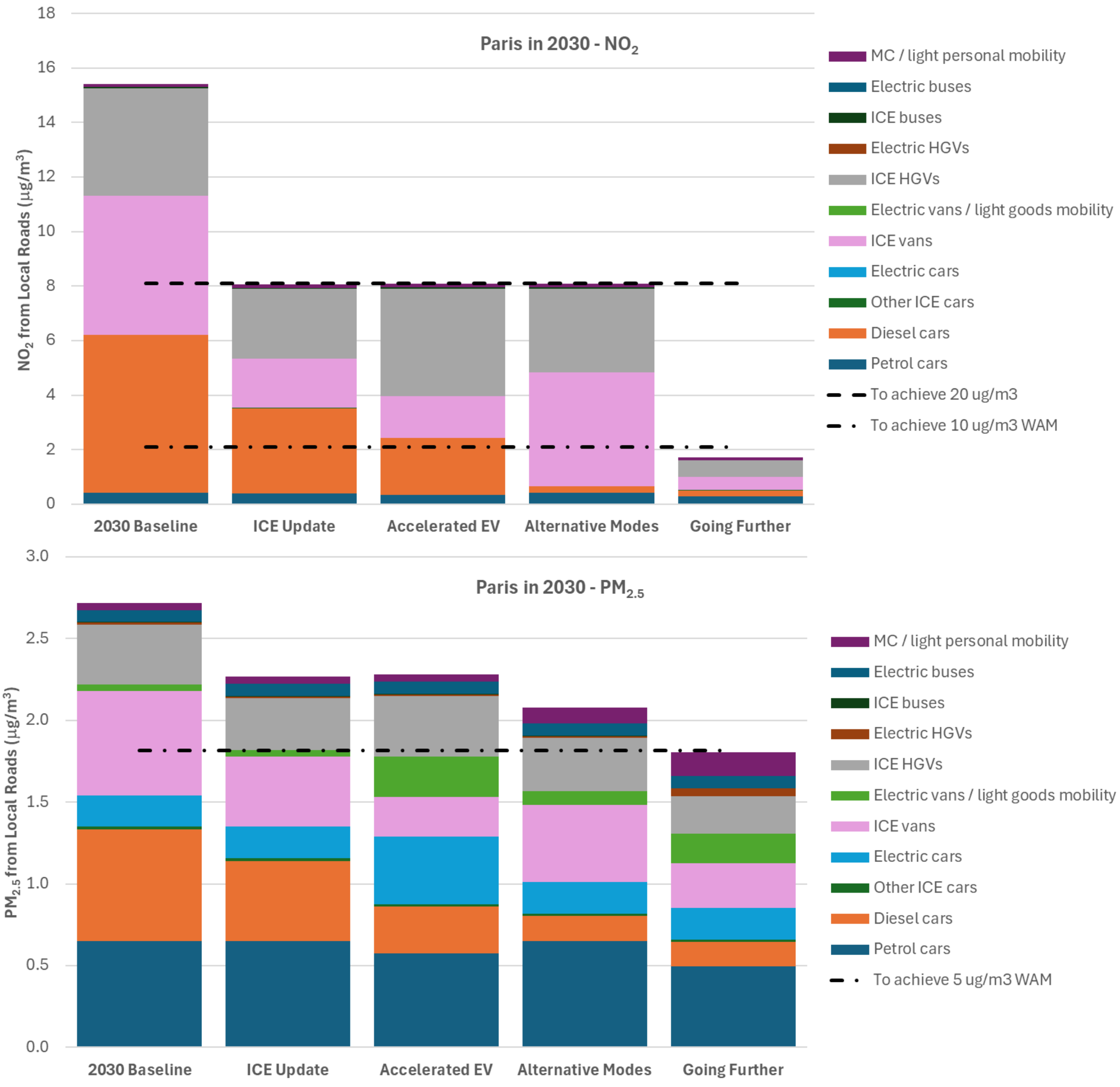


Figure 3-2: NO$_2$ and PM$_{2.5}$ Concentrations from Local Roads in 2030 at the Worst-case Monitoring Location in Greater Paris in the Baseline Scenario and with Four Alternative Packages of Interventions.

2040

3.6 Table 5 summarises the local transport interventions which have been assessed for the four alternative intervention packages. Figure 3-3 shows the effect that each of these packages of measures would have on the local road component of concentrations at the worst-case monitoring site in Greater Paris in 2040. It also shows (in a dashed line) the local road contributions below which the 10 µg/m^3 NO$_2$ WHO guideline would be achieved. Finally, it shows (in a dash-dot line) the local road contributions below which the 5 µg/m^3 (PM$_{2.5}$) WHO guidelines would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. Lines for the limit values are not shown since they are already predicted to be achieved in the 2040 baseline.

3.7 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions have all been designed to achieve the 10 µg/m^3 NO$_2$ WHO guideline using alternative solutions. The 'Going Further' package of interventions shows what could be achieved using a combination of all available approaches. If the WAM reductions in Table 3 were also delivered, the 'Going Further' package would allow attainment not only of the WHO guideline for NO_2, but also for $PM_{2.5}$.

Table 5: Summary of Local Transport Interventions Assessed for Greater Paris in 2040

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 6 and 70% of Euro 6a/b diesel cars upgraded to Euro 6d	15% of the non-EV car fleet upgraded to EV (all diesel cars and 10% of conventional petrol cars)	Focusing on older vehicles, 32% reduction in total car trips (10% replaced with electric light mobility, 10% with car share, and 12% with active travel and public transport)	Focusing on non-EV cars, 45% reduction in total car trips (5% replaced with electric light mobility, 10% with car share, and 30% with active travel and public transport)
Vans	All pre-Euro 6d-temp vans upgraded to Euro 6d	26% of the non-EV van fleet upgraded to EV (all pre-Euro 6 diesel vans and 20% of Euro 6 a/b diesel vans)	Focusing on older diesel vehicles, 25% van fleet replaced with electric light mobility	25% of conventional vans upgraded to EV and 25% replaced with electric light mobility. All remaining vans Euro 6d
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	20% of the non-EV HGV fleet upgraded to EV (All pre-Euro V HGVs and 62% of Euro V HGVs)	All pre-Euro VI HGVs upgraded to Euro VI	50% of all pre-Euro VI HGVs upgraded to Euro VI and 50% upgraded to EV
L-cat	No change	No change	No change to the baseline L-category fleet	All pre-Euro 3 L-category vehicles upgraded to Euro 3-5 (in proportion to baseline distribution)
Buses	No change	No change	No change	Fully electric

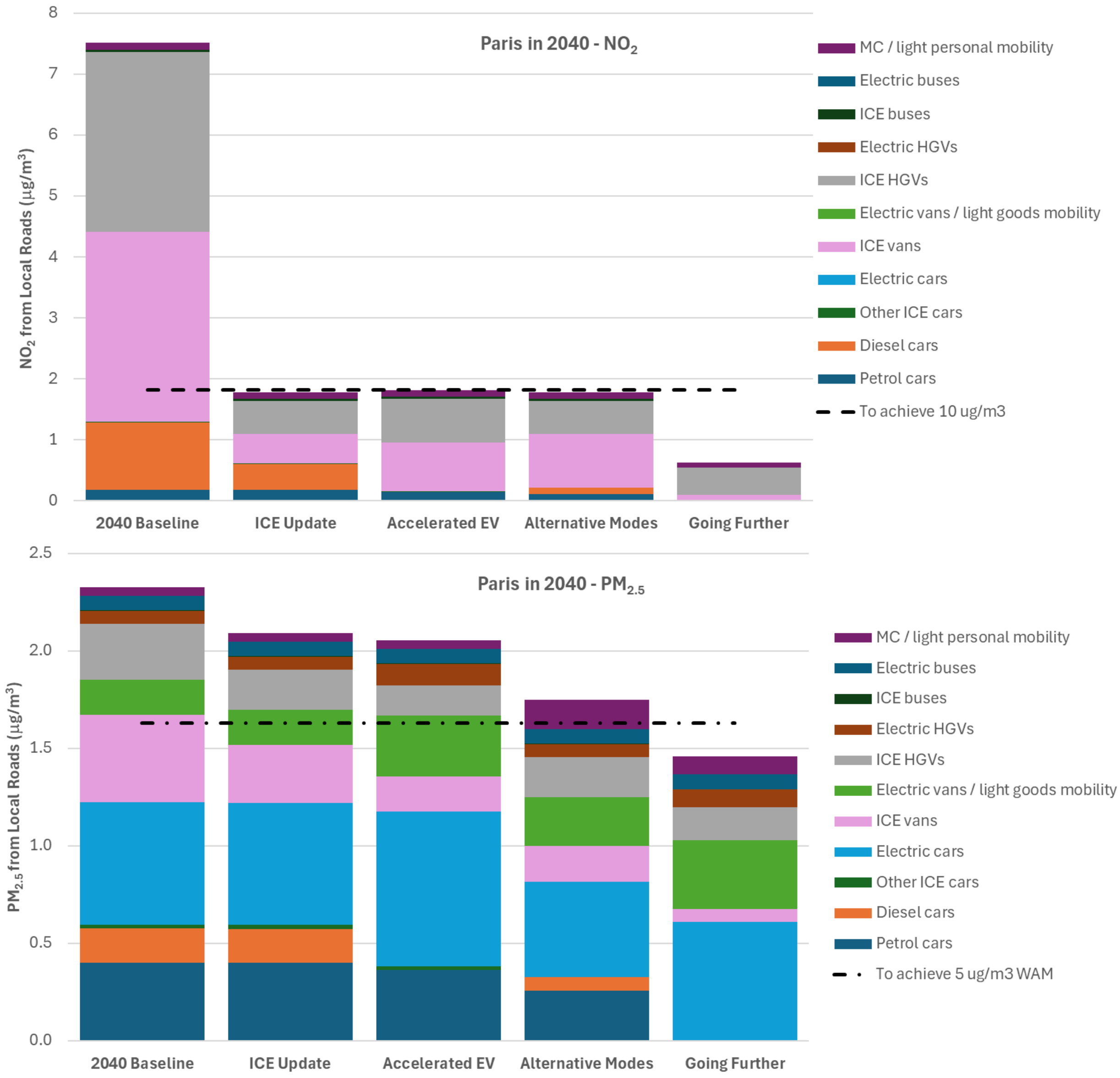


Figure 3-3: NO$_2$ and PM$_{2.5}$ Concentrations from Local Roads in 2040 at the Worst-case Monitoring Location in Greater Paris in the Baseline Scenario and with Four Alternative Packages of Interventions.

4 Results for Milan

Current and Future Baseline Concentrations

4.1 Figure 4-1 summarises the predicted baseline concentrations in Milan. The background concentrations shown are those forecast directly from the baseline EMEP modelling for the Gothenburg Protocol revision and do not take account of any of the WAM reductions in Table 3.

4.2 Annual mean NO_2 concentrations are predicted to fall from 43.8 $\mu g/m^3$ in 2023 to 14.8 $\mu g/m^3$ in 2040. Most of this reduction is driven by forecast changes to the local vehicle fleet, but appreciable reductions to the 'background' component are also predicted, particularly between 2023 and 2030. The limit value of 20 $\mu g/m^3$ will be exceeded in 2030 but achieved in 2040. The WHO guideline of 10 $\mu g/m^3$ is predicted to be exceeded in each year.

4.3 Annual mean $PM_{2.5}$ concentrations are predicted to fall from 19.6 $\mu g/m^3$ in 2023 to 12.1 $\mu g/m^3$ in 2040. Most of this is driven by forecast changes to the 'background' component of concentrations, with only limited reductions to the concentrations arising from local traffic. This reflects the importance on non-exhaust emissions (principally brake, tyre and road wear) to local $PM_{2.5}$ concentrations and the fact that these emissions will continue to be important for modern and electric vehicles. The limit value of 10 $\mu g/m^3$ is predicted to be exceeded in all years; the WHO target of 5 $\mu g/m^3$ will also, therefore, be exceeded. The 'background' component of concentrations is predicted to exceed 5 $\mu g/m^3$ in all years by a substantial margin. This means that the 5 $\mu g/m^3$ WHO target is unlikely to be achieved without substantial and significant effort covering multiple sectors.

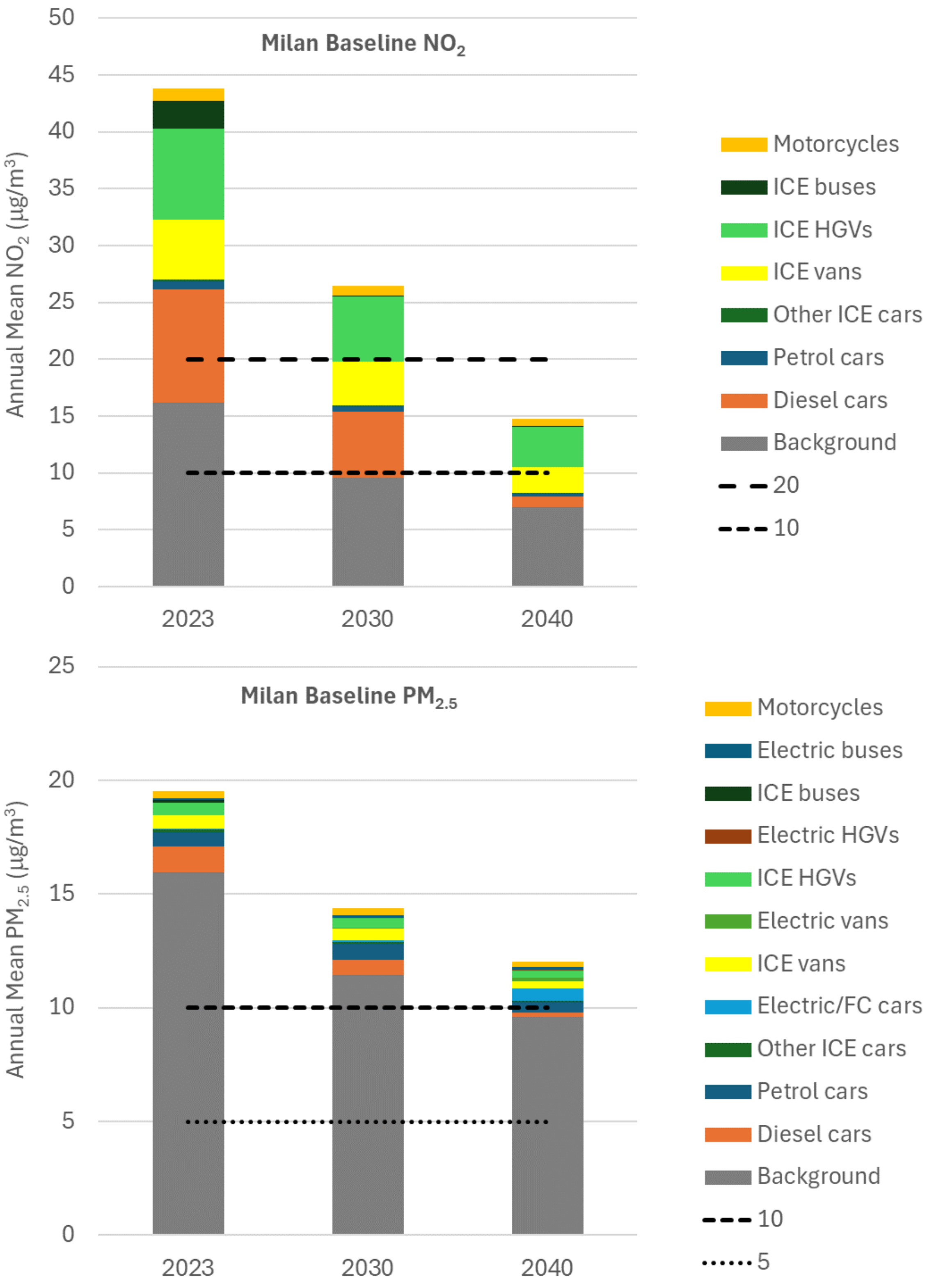


Figure 4-1: Current and Future Baseline NO_2 and $PM_{2.5}$ Concentrations at Worst-case Monitoring Location in Milan in 2023, 2030 and 2040

Local Transport Interventions

2030

4.4 Table 6 summarises the local transport interventions which have been assessed for the four alternative intervention packages: 'ICE Update', 'Accelerated EV', 'Alternative Modes' and 'Going Further'. Figure 4-2 shows the effect that each of these packages of measures would have on the local road component of concentrations. It also shows (in a dashed line) the local road contributions below which the 20 µg/m³ NO_2 limit value would be achieved. Finally, it shows (in dash-dot lines) the local road contributions below which the 10 µg/m³ NO_2 WHO guideline and 10 µg/m³ $PM_{2.5}$ limit value would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. A line for the 5 µg/m³ $PM_{2.5}$ WHO guideline is not shown since achieving the 10 µg/m³ limit value by 2030 will already require appreciable additional reductions.

4.5 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions have all been designed to achieve the 20 µg/m³ NO_2 limit value using alternative solutions. The 'Going Further' package of interventions shows what could be achieved using a combination of all available approaches. If the WAM reductions in Table 3 were also delivered, the 'Going Further' package would allow attainment not only of both limit values, but also of the WHO guideline for NO_2 by 2030. The 5 µg/m³ $PM_{2.5}$ WHO guideline would continue to be exceeded in all scenarios.

Table 6: Summary of Local Transport Interventions Assessed for Milan in 2030

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 4 cars upgraded to Euro 6d. All Euro 4 diesel cars upgraded to Euro 6d. 58% of Euro 5 diesel cars upgraded to Euro 6d	18% of the non-EV car fleet upgraded to EV (all pre-Euro 5 cars, and 94% of Euro 5 conventional diesel cars)	Focusing on older diesel cars, 20% reduction in total car trips (5% replaced with electric light mobility, 5% with car share, and 10% with active travel and public transport)	Focusing on older (pre-Euro 4) and particularly older diesel (pre-Euro 6d temp) cars, 23% reduction in total car trips (5% replaced with electric light mobility, 5% with car share, and 13% with active travel and public transport)
Vans	All pre-Euro 4 vans upgraded to Euro 6d	32% of the non-EV van fleet upgraded to EV (all pre-Euro 5 vans)	Focusing on older vehicles 4% of van fleet replaced with electric light mobility.	Focusing on older vehicles, 15% of van fleet replaced with EVs and 15% with electric light mobility. Pre-Euro 6 vans upgraded to Euro 6d
HGVs	All pre-Euro IV HGVs upgraded to Euro VI	7% of the non-EV HGV fleet upgraded to EV (all pre-Euro III HGVs)	All pre-Euro III HGVs upgraded to Euro VI	75% of all pre-Euro VI HGVs upgraded to Euro VI, with 25% upgraded to EV
L-cat	No change	No change	No change to the baseline L-category fleet	All pre-Euro 3 L-category vehicles upgraded to Euro 3-5 (in proportion to baseline distribution)
Buses	No change	No change	No change	Fully electric

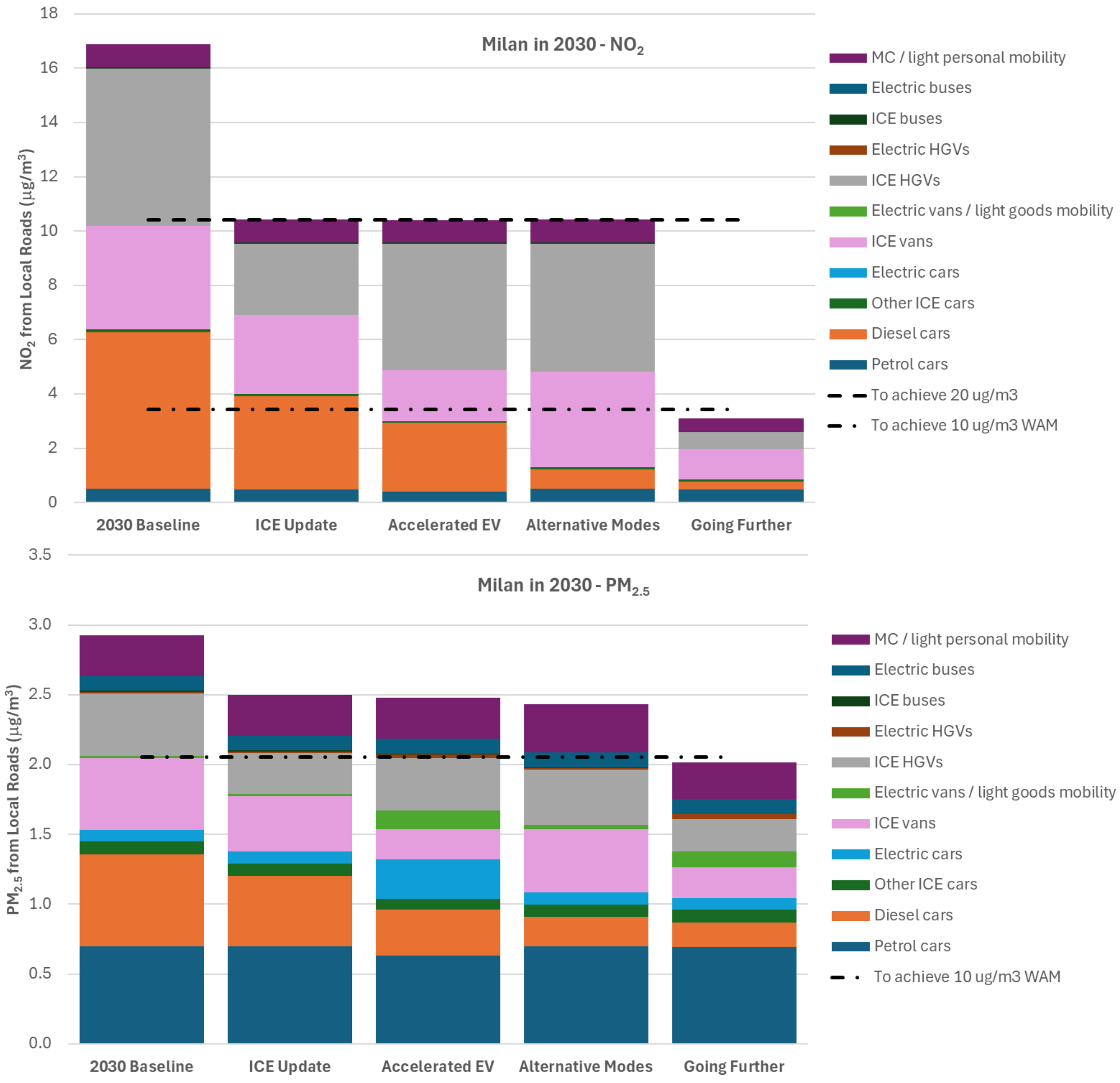


Figure 4-2: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2030 at the Worst-case Monitoring Location in Milan in the Baseline Scenario and with Four Alternative Packages of Interventions

2040

4.6 Table 7 summarises the local transport interventions which have been assessed for the four alternative intervention packages. Figure 4-3 shows the effect that each of these packages of measures would have on the local road component of concentrations in 2040. It also shows (in a dashed line) the local road contributions below which the 10 μg/m^3 NO_2 WHO guideline would be achieved. Finally, it shows (in a dash-dot line) the local road contributions below which the 10 μg/m^3 $PM_{2.5}$ limit value would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. A line for the 5 μg/m^3 $PM_{2.5}$ WHO guideline is not shown since achieving the 10 μg/m^3 limit value will already require significant additional (WAM) reductions and a line for the 20 μg/m^3 NO_2 limit value is not shown since it will already be achieved in the 2040 baseline.

4.7 The ‘ICE Update’, ‘Accelerated EV’, and ‘Alternative Modes’ packages of interventions have all been designed to achieve the 10 μg/m^3 NO_2 WHO guideline using alternative solutions. The ‘Going Further’ package of interventions shows what could be achieved using a combination of all available approaches. If the WAM reductions in Table 3 were also delivered, both the 'Alternative Modes' and 'Going Further' packages would allow attainment not only of the WHO guideline for NO_2, but also the 10 $\mu g/m^3$ limit value for $PM_{2.5}$. The 5 $\mu g/m^3$ $PM_{2.5}$ WHO guideline would continue to be exceeded in all scenarios and its achievement would require significant additional reductions to emissions from non-traffic sources.

Table 7: Summary of Local Transport Interventions Assessed for Milan in 2040

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 6 diesel cars upgraded to Euro 6d	4% of the non-EV car fleet upgraded to EV (all pre-Euro 6d diesel cars)	Focusing on older cars, 32% reduction in total car trips (10% replaced with electric light mobility, 10% with car share, and 12% with active travel and public transport)	Focusing on diesel and older petrol cars, 50% reduction in total car trips (12% replaced with electric light mobility, 15% with car share, and 23% with active travel and public transport)
Vans	All pre-Euro 6 diesel vans upgraded to Euro 6d	26% of the non-EV van fleet upgraded to EV (all pre-Euro 6 vans)	Focusing on older vehicles, 20% van fleet replaced with electric light mobility	All conventional vans upgraded to Euro 6d, and 25% of van trips replaced with electric light mobility
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	14% of the non-EV HGV fleet upgraded to EV (all pre-Euro IV HGVs)	All pre-Euro V and 20% of Euro V HGVs upgraded to Euro VI	Double the proportion of EV HGVs, with all remaining HGVs upgraded to Euro VI
L-cat	All pre-Euro 2 L-category vehicles upgraded to Euro 2-5 (in proportion to baseline distribution)	13% of L-category vehicles Upgraded to EV (all pre-Euro 3 vehicles)	No change to the baseline L-category fleet	All pre-Euro 3 L-category vehicles upgraded to Euro 3-5 (in proportion to baseline distribution)
Buses	No change	Fully electric	No change	Fully electric

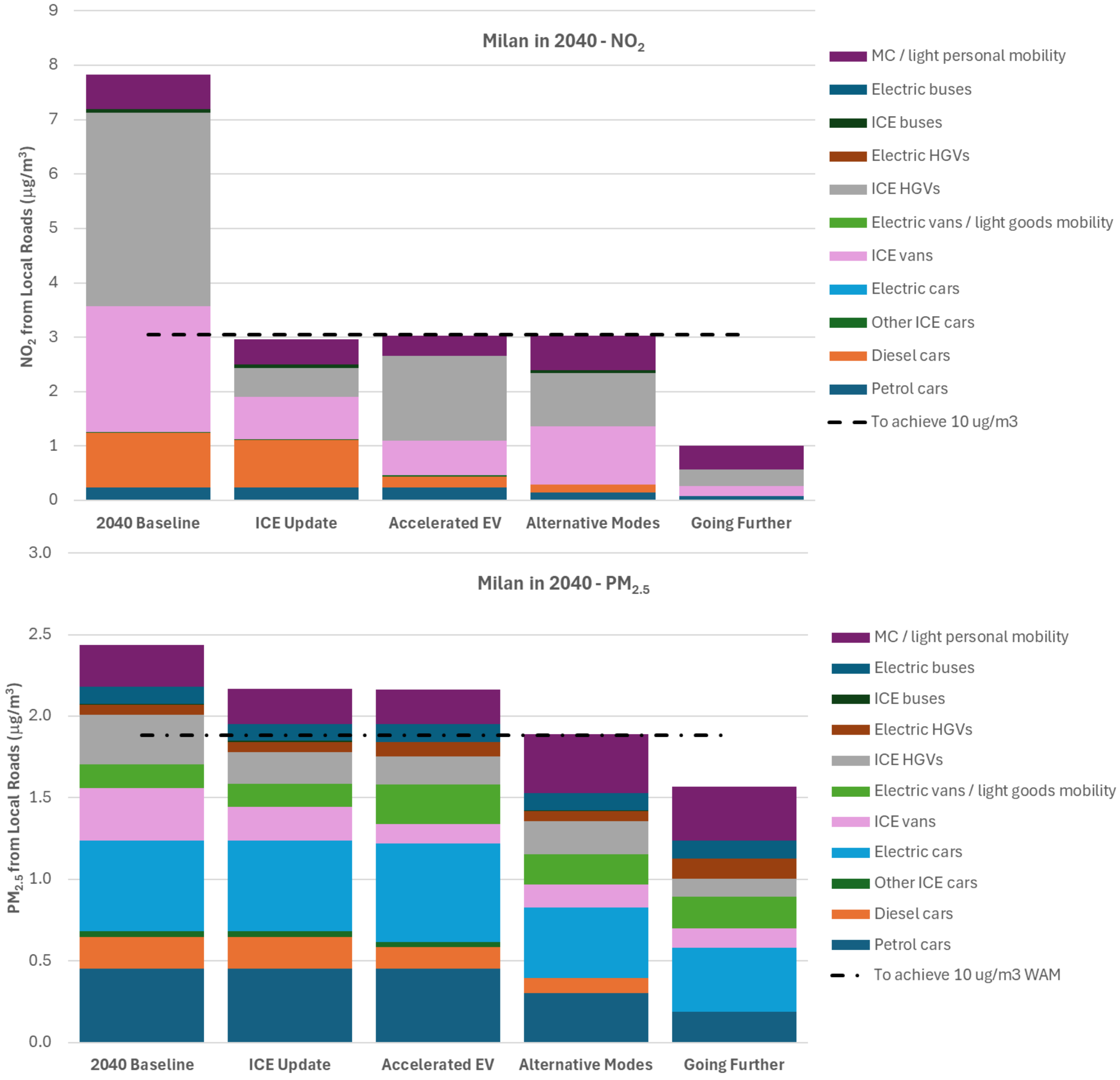


Figure 4-3: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2040 at the Worst-case Monitoring Location in Milan in the Baseline Scenario and with Four Alternative Packages of Interventions

5 Results for Warsaw

Current and Future Baseline Concentrations

5.1 Figure 5-1 summarises the predicted baseline concentrations at the worst-case monitoring site in Warsaw. The background concentrations shown are those forecast directly from the baseline EMEP modelling for the Gothenburg Protocol revision and do not take account of any of the WAM reductions in Table 3.

5.2 Annual mean NO_2 concentrations are predicted to fall from 42.7 $\mu g/m^3$ in 2023 to 23.6 $\mu g/m^3$ in 2040. Most of this reduction is driven by forecast changes to the local vehicle fleet, but appreciable reductions to the 'background' component are also predicted. Both the limit value of 20 $\mu g/m^3$ and the WHO guideline of 10 $\mu g/m^3$ are predicted to be exceeded in each year. The 'background' component of concentrations is predicted to exceed 10 $\mu g/m^3$ in 2030 and 2040, meaning that even the complete removal of all local transport emissions could not, on its own, achieve the WHO guideline.

Annual mean $PM_{2.5}$ concentrations are predicted to fall from 16.0 $\mu g/m^3$ in 2023 to 10.5 $\mu g/m^3$ in 2040. This is driven by forecast changes to the 'background' component of concentrations; $PM_{2.5}$ from local road traffic is predicted to increase between 2030 and 2040. This reflects the importance on non-exhaust emissions (principally brake, tyre and road wear) to local $PM_{2.5}$ concentrations and the expectation that traffic volumes in Warsaw will increase over this period. The limit value of 10 $\mu g/m^3$ and WHO target of 5 $\mu g/m^3$ will be exceeded in all years. The 'background' component of concentrations is predicted to exceed 5 $\mu g/m^3$ in both 2030 and 2040, meaning that even the complete removal of all local transport emissions could not, on its own, achieve the WHO standard in either year without additional reductions from other sources.

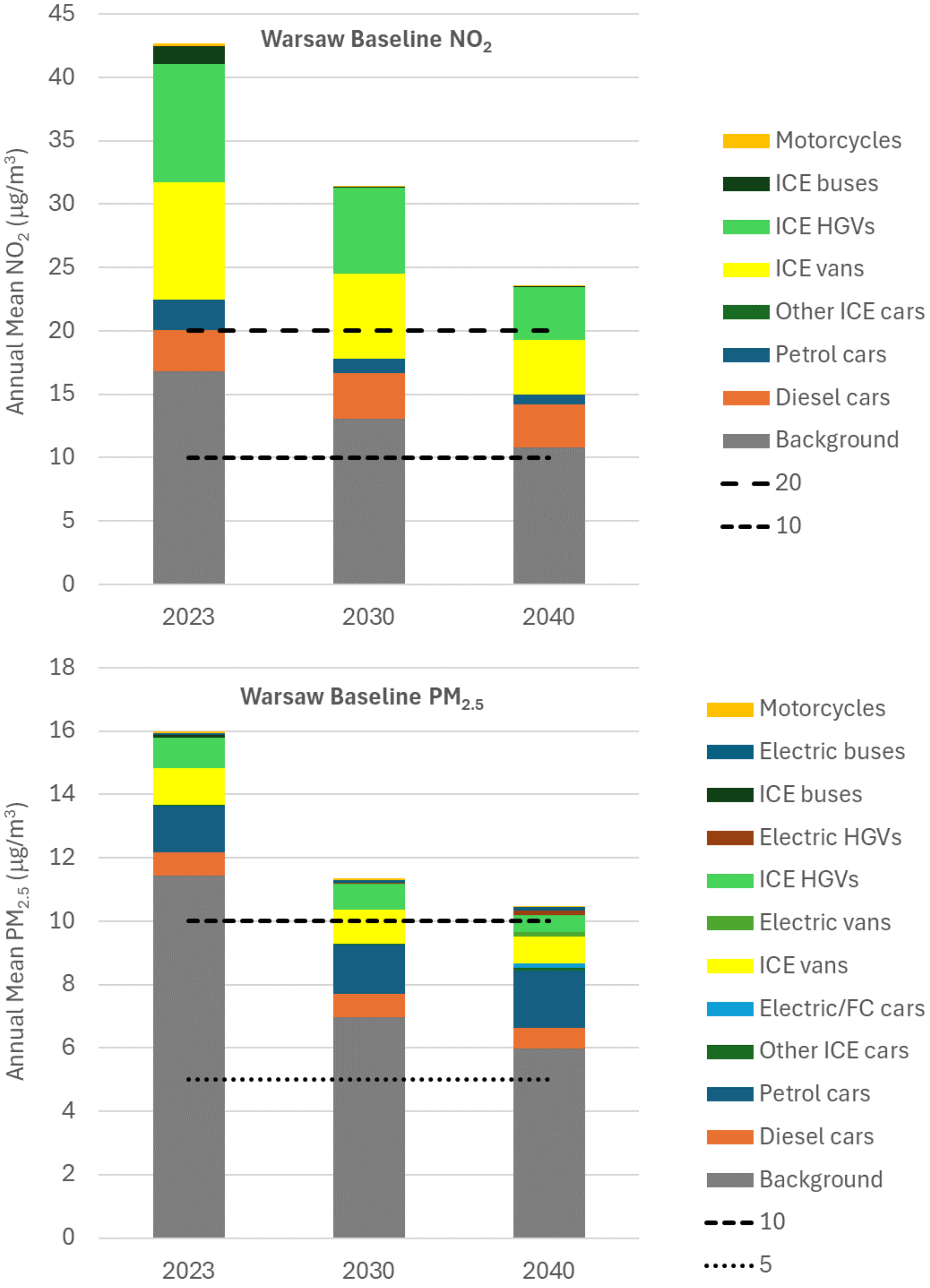


Figure 5-1: Current and Future Baseline NO_2 and $PM_{2.5}$ Concentrations at Worst-case Monitoring Location in Warsaw in 2023, 2030 and 2040

Local Transport Interventions

2030

5.3 Table 8 summarises the local transport interventions which have been assessed for the four alternative intervention packages: 'ICE Update', 'Accelerated EV', 'Alternative Modes' and 'Going Further'. Figure 5-2 shows the effect that each of these packages of measures would have on the local road component of concentrations at the worst-case monitoring site in Warsaw. It also shows (as dashed lines) the local road contributions below which the 20 $\mu g/m^3$ (NO_2) and 10 $\mu g/m^3$ ($PM_{2.5}$) limit value would be achieved (the WHO guidelines are not shown since, as shown in Figure 5-1, they would not be achieved even with the complete removal of all local traffic emissions).

5.4 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions have all been designed to achieve the 20 $\mu g/m^3$ NO_2 limit value using alternative solutions. The 'Going Further' package of interventions shows what could be achieved using a combination of all available approaches and shows how the 10 $\mu g/m^3$ $PM_{2.5}$ limit value could also be achieved in Warsaw in 2030.

Table 8: Summary of Local Transport Interventions Assessed for Warsaw in 2030

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 4 cars upgraded to Euro 6d. All pre-Euro 6 diesel cars upgraded to Euro 6d	54% of the non-EV car fleet upgraded to EV (all pre-Euro 5 cars, and all Euro 5 conventional diesel cars)	Focusing on older cars (pre-Euro 4) and older diesel cars (pre-Euro 6d-temp) 20% reduction in total car trips (5% replaced with electric light mobility, 10% with car share, and 10% with active travel and public transport)	Focusing on older (pre-Euro 5) and particularly older diesel (pre-Euro 6d Temp) cars, 43% reduction in total car trips (10% replaced with electric light mobility, 20% with car share, and 13% with active travel and public transport)
Vans	All pre-Euro 6 vans upgraded to Euro 6d	36% of the non-EV van fleet upgraded to EV (all pre-Euro 6 vans)	Focusing on older vehicles 36% of van fleet replaced with electric light mobility	9% of conventional vans upgraded to EV and 9% replaced with electric light mobility. All remaining vans Euro 6d
HGVs	All pre-Euro V and 55% of Euro V HGVs upgraded to Euro VI	21% of the non-EV HGV fleet upgraded to EV (all pre-Euro IV HGVs)	All pre-Euro V HGVs upgraded to Euro VI	All pre-Euro VI HGVs upgraded to Euro VI
L-cat	No change	No change	No change to the baseline L-category fleet	No change to the baseline L-category fleet
Buses	No change	No change	No change	No change

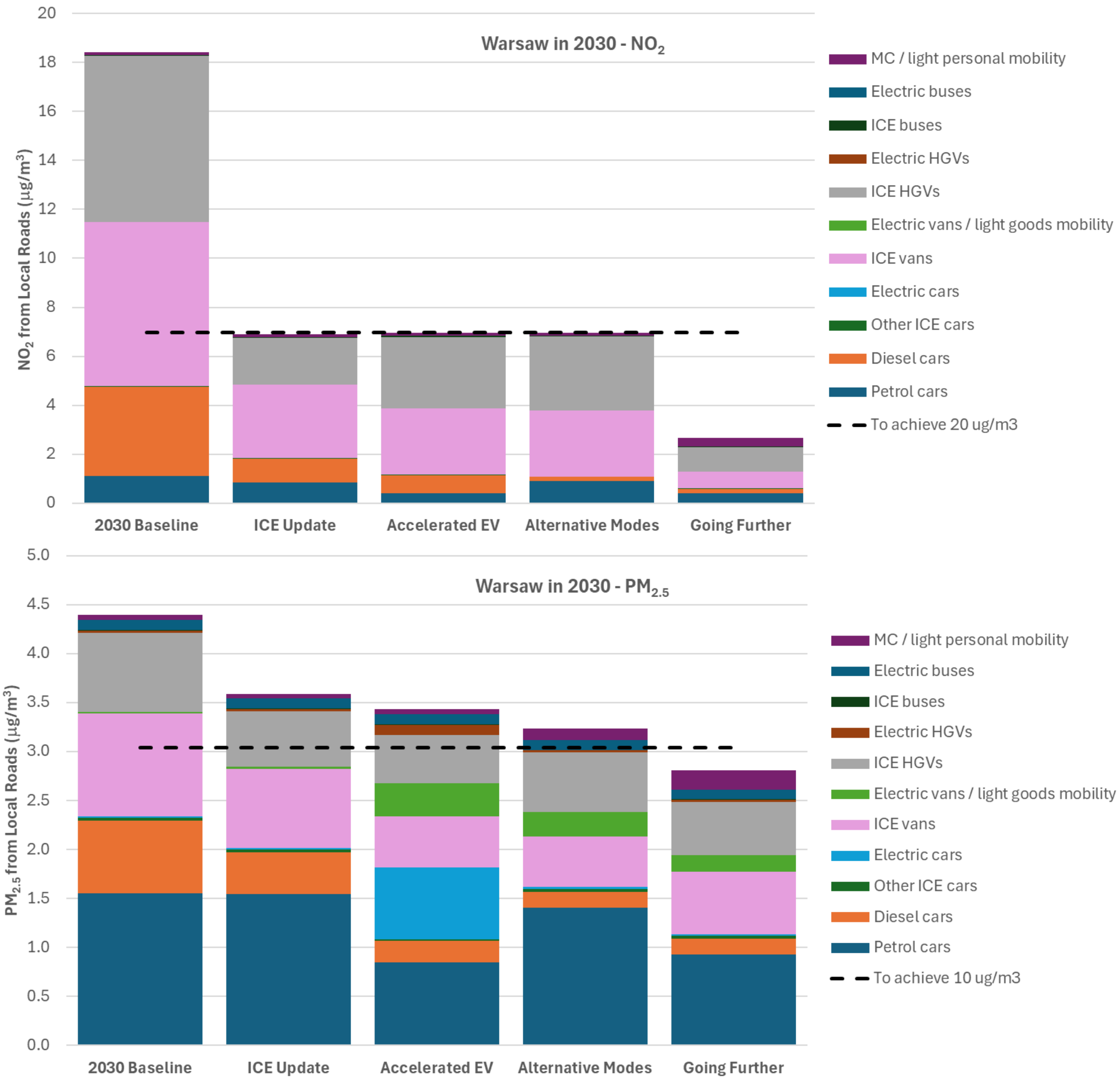


Figure 5-2: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2030 at the Worst-case Monitoring Location in Warsaw Paris in the Baseline Scenario and with Four Alternative Packages of Interventions

2040

5.5 Table 9 summarises the local transport interventions which have been assessed for the four alternative intervention packages in 2040. Figure 5-3 shows the effect that each of these packages of measures would have on the local road component of concentrations at the worst-case monitoring site in Warsaw. It also shows (as dashed lines) the local road contributions below which the 20 μg/m³ (NO_2) and 10 μg/m³ ($PM_{2.5}$) limit values would be achieved. Finally, it shows (in dash-dot lines) the local road contributions below which the 10 μg/m³ (NO_2) and 5 μg/m³ ($PM_{2.5}$) WHO guidelines would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered.

5.6 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions will all comfortably allow the 20 μg/m³ NO_2 limit value to be achieved using alternative solutions. The 'Accelerated EV', and 'Alternative Modes' interventions will also allow the 10 μg/m³ $PM_{2.5}$ limit value to be achieved, while the ‘Accelerated EV’ package would allow achievement of the 10 µg/m^3 NO_2 WHO guideline. The ‘Going Further’ package of interventions shows what could be achieved using a combination of all available approaches and shows how the WHO guidelines for both NO_2 and $PM_{2.5}$ could potentially be achieved if the additional WAM reductions to non-transport $PM_{2.5}$ in Table 3 were also delivered.

Table 9: Summary of Local Transport Interventions Assessed for Warsaw in 2040

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 6 cars upgraded to Euro 6d. All pre-Euro 6 d diesel cars upgraded to Euro 6d	57% of the non-EV car fleet upgraded to EV (all pre-Euro 6 cars, all pre-Euro 6 d diesel cars, and 70% of conventional Euro 6d diesel cars)	Focusing on diesel cars, 24% reduction in total car trips (10% replaced with electric light mobility, 4% with car share, and 10% with active travel and public transport)	Focusing on diesel and older petrol cars, 50% reduction in total car trips (12% replaced with electric light mobility, 15% with car share, and 23% with active travel and public transport)
Vans	All pre-Euro 6d vans upgraded to Euro 6d	37% of the non-EV van fleet upgraded to EV (all pre-Euro 6d vans)	Focusing on older vehicles, 22% van fleet replaced with electric light mobility	15% of conventional vans upgraded to EV and 5% replaced with electric light mobility. All remaining vans Euro 6d
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	21% of the non-EV HGV fleet upgraded to EV (all pre-Euro VI HGVs)	All pre-Euro VI HGVs upgraded to Euro VI	10% of HGVs upgraded to EV. All remaining HGVs Euro VI
L-cat	All pre-Euro 3 L-category vehicles upgraded to Euro 5	no change	No change to the baseline L-category fleet	No change to the baseline L-category fleet
Buses	No change	Fully electric	No change	Fully electric

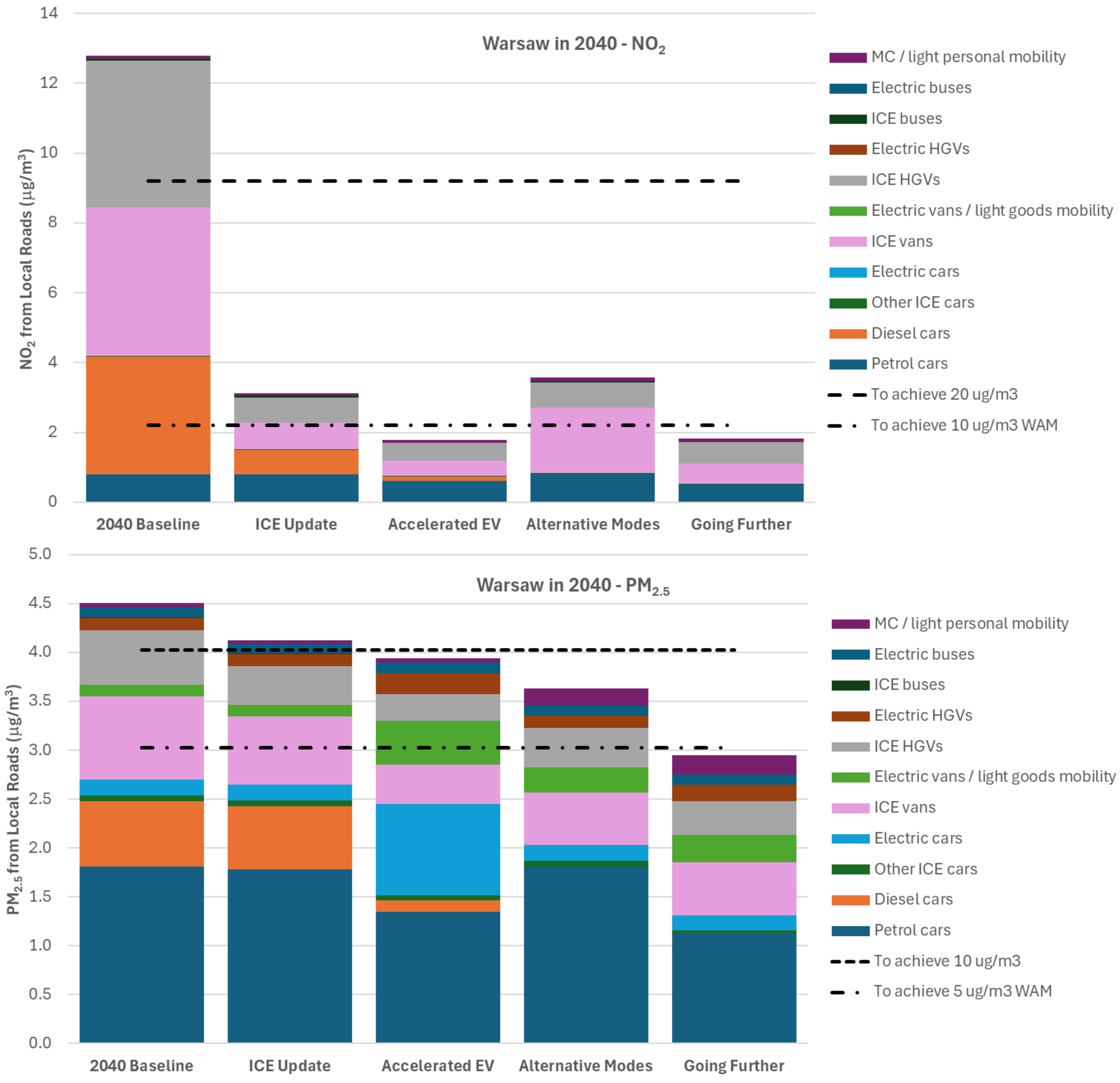


Figure 5-3: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2040 at the Worst-case Monitoring Location in Warsaw in the Baseline Scenario and with Four Alternative Packages of Interventions

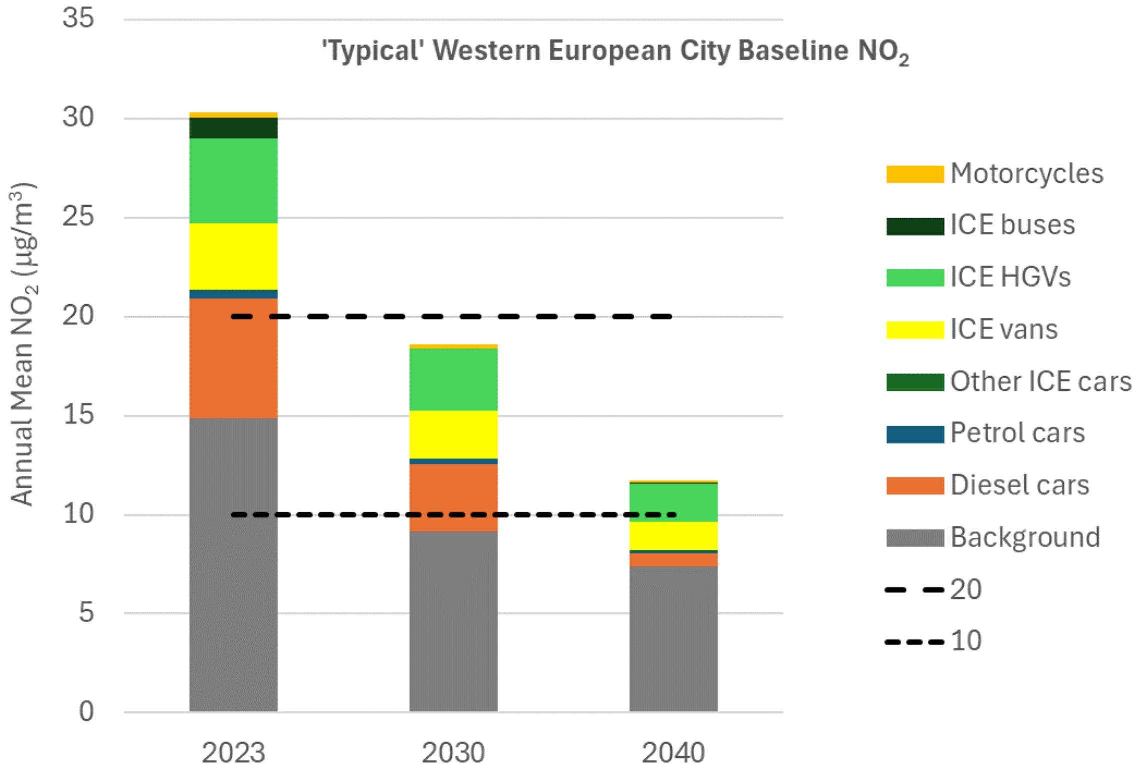
6 Results for the 'Typical' Western European City

Current and Future Baseline Concentrations

6.1 Figure 6-1 summarises the predicted baseline concentrations at a roadside monitor within a 'typical' Western European city. As explained in Section 2, the roadside concentrations represent the upper quartile across all relevant fixed monitors in Western Europe. The background concentrations for 2023 are the means across all relevant fixed monitors in Western Europe, forecast forward using the baseline EMEP modelling for the Gothenburg Protocol revision. They do not take account of any of the WAM reductions in Table 3.

6.2 Annual mean NO_2 concentrations are predicted to fall from 30.3 $\mu g/m^3$ in 2023 to 11.8 $\mu g/m^3$ in 2040. Most of this reduction is driven by forecast changes to the local vehicle fleet. Only relatively small reductions in the 'background' component are predicted between 2030 and 2040, which is based on the average forecast trajectory at all relevant background locations. The limit value of 20 $\mu g/m^3$ is predicted to be achieved in both 2030 and 2040. The WHO guideline of 10 $\mu g/m^3$ is predicted to be exceeded in each year. The 'background' component of concentrations is predicted to take up most of the 10 $\mu g/m^3$ WHO guideline in 2030, meaning that transport emissions would need to reduce to close to zero for the WHO guideline to be achieved in this year unless improvements from other sectors were also achieved. It is, however, noted that the trajectory for future NO_2 concentrations is quite variable across different Western European cities and so some locations will see much greater reductions in the 'background' concentrations than others. This is disguised by the average shown in Figure 6-1.

Annual mean $PM_{2.5}$ concentrations are predicted to fall from 11.6 $\mu g/m^3$ in 2023 to 7.9 $\mu g/m^3$ in 2040. This is driven by forecast changes to the 'background' component of concentrations, with only small reductions to the local road traffic component. This reflects the importance on non-exhaust emissions (principally brake, tyre and road wear) to local $PM_{2.5}$ concentrations. The limit value of 10 $\mu g/m^3$ is predicted to be achieved in both 2030 and 2040. The WHO target of 5 $\mu g/m^3$ will be exceeded in all years. The 'background' component of concentrations is predicted to exceed 5 $\mu g/m^3$ in both 2030 and 2040, meaning that even the complete removal of all local transport emissions could not, on its own, achieve the WHO standard in either year without additional WAM reductions. However, as explained above for NO_2, the trajectory for future concentrations is quite variable across different Western European cities and so some locations will see much greater reductions in the 'background' concentrations than others. This is disguised by the average shown in Figure 6-1.



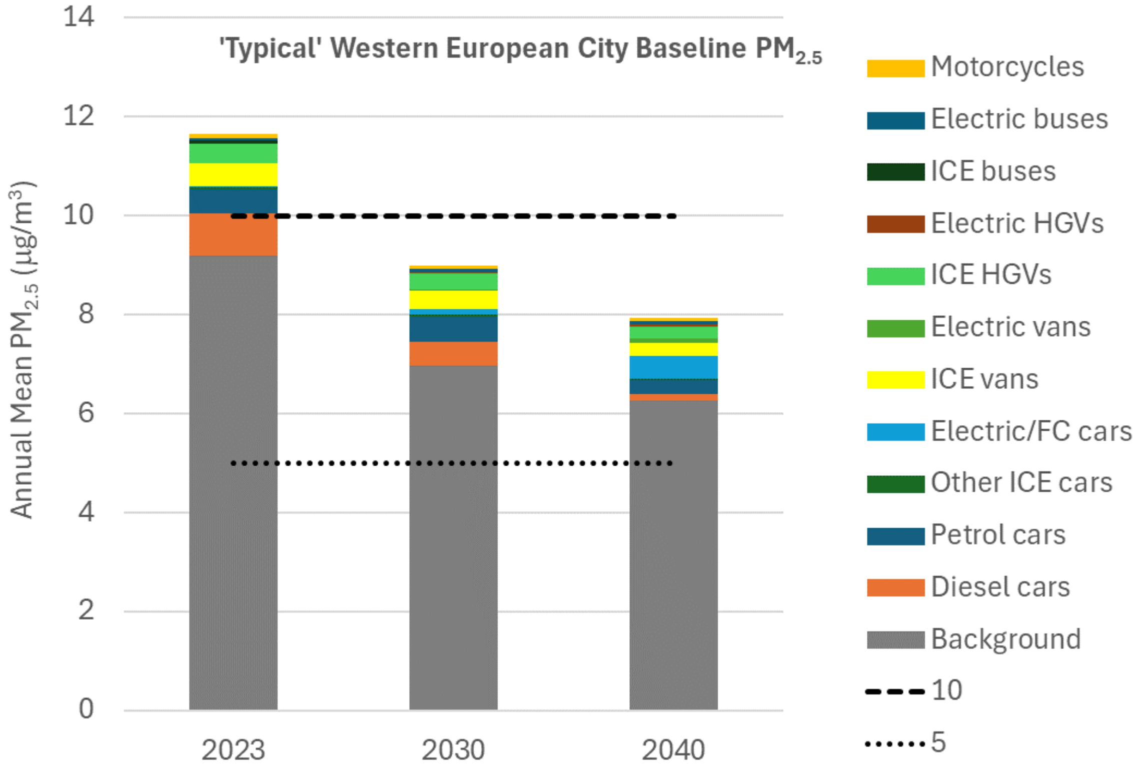


Figure 6-1: Current and Future Baseline NO_2 and $PM_{2.5}$ Concentrations at Worst-case Monitoring Location in a 'Typical' Western European City in 2023, 2030 and 2040

Local Transport Interventions

2030

6.3 Table 10 summarises the local transport interventions which have been assessed for the four alternative intervention packages: 'ICE Update', 'Accelerated EV', 'Alternative Modes' and 'Going Further'. Figure 6-2 shows the effect that each of these packages of measures would have on the local road component of concentrations. It also shows (in a dashed line) the local road contributions below which the 10 µg/m³ NO_2 WHO guideline limit value would be achieved, and (in dash-dot lines) the local road contributions below which the 10 µg/m³ (NO_2) and 5 µg/m³ ($PM_{2.5}$) WHO guidelines would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. Lines for the limit values are not shown since both limit values are predicted to be achieved in 2030 even without any local transport interventions.

6.4 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions would all achieve the 10 µg/m³ NO_2 WHO guideline (using alternative solutions) assuming additional WAM reductions. The 'Going Further' package of interventions shows what could be achieved using a combination of all available approaches. In this case, the 10 µg/m³ NO_2 WHO guideline would be achieved even without any additional WAM reductions. If the WAM reductions to $PM_{2.5}$ concentrations in Table 3 were also delivered, the 'Going Further' package would allow attainment of the WHO $PM_{2.5}$ guideline in 2030.

Table 10: Summary of Local Transport Interventions Assessed for a 'Typical' Western European City in 2030

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 4 cars upgraded to Euro 6d. All Euro 4 and 5 diesel cars upgraded to Euro 6d	14% of the non-EV car fleet upgraded to EV (all pre-Euro 6 diesel cars)	Focusing on older diesel cars, 25% reduction in total car trips (10% replaced with electric light mobility, 5% with car share, and 10% with active travel and public transport)	20% increase in EVs. In addition, focusing on diesel and older petrol cars, 42% reduction in total car trips (15% replaced with electric light mobility, 7% with car share, and 20% with active travel and public transport)
Vans	All pre-Euro 6 diesel vans upgraded to Euro 6d	41% of the non-EV van fleet upgraded to EV (all pre-Euro 6 diesel vans)	Focusing on older vehicles 25% of van fleet replaced with electric light mobility.	50% of pre-Euro 6d diesel vans upgraded to Euro 6d, 25% upgraded to EV, and 25% replaced with electric light mobility
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	39% of the non-EV HGV fleet upgraded to EV (all pre-Euro VI HGVs)	All pre-Euro IV HGVs upgraded to Euro VI	15% of non-EV HGVs upgraded to EV, the remainder all Euro VI
L-cat	No change	No change	No change to the baseline L-category fleet	No change to the baseline L-category fleet
Buses	No change	No change	No change	No change

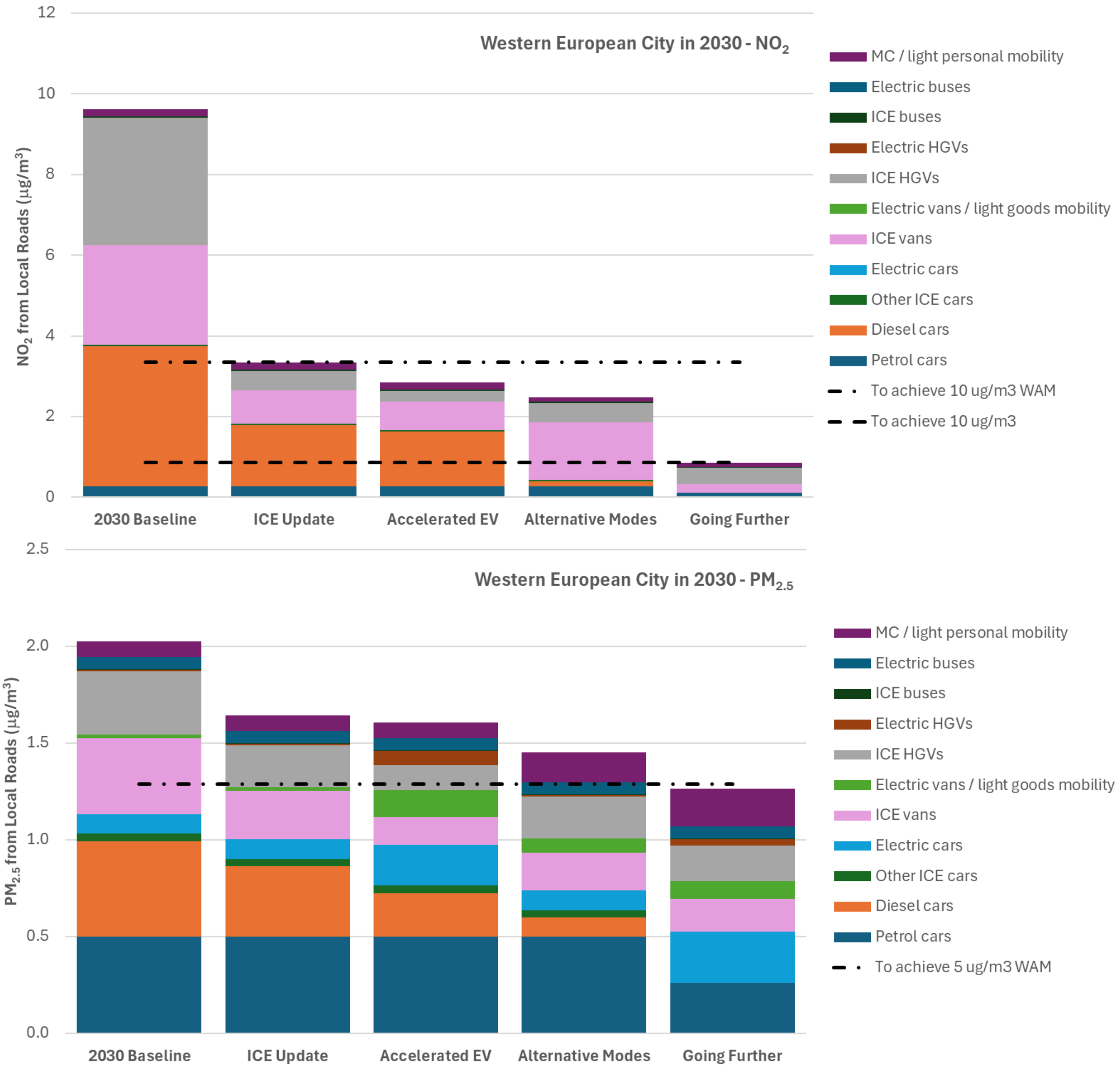


Figure 6-2: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2030 in a 'Typical' Western European City in the Baseline Scenario and with Four Alternative Packages of Interventions

2040

6.5 Table 11 summarises the local transport interventions which have been assessed for the four alternative intervention packages in 2040. Figure 6-3 shows the effect that each of these packages of measures would have on the local road component of concentrations. It also shows (as a dashed line) the local road contributions below which the 10 µg/m³ NO_2 WHO guideline would be achieved. Finally, it shows (as a dash-dot line) the local road contributions below which the 5 µg/m³ ($PM_{2.5}$) WHO guidelines would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. Lines for the limit values are not shown since both limit values are predicted to be achieved in 2040 even without any local transport interventions.

6.6 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions would all achieve the 10 µg/m³ NO_2 WHO guideline using alternative approaches. The 'Going Further' package of interventions shows what could be achieved using a combination of all available solutions. If the WAM reductions in Table 3 were delivered, the 'Going Further' package of interventions would also allow attainment of the WHO guideline for $PM_{2.5}$.

Table 11: Summary of Local Transport Interventions Assessed for a 'Typical' Western European City in 2040

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 6 diesel cars upgraded to Euro 6d	12% of the non-EV car fleet upgraded to EV (all diesel cars except Euro 6d hybrids)	Focusing on older vehicles, 30% reduction in total car trips (10% replaced with electric light mobility, 10% with car share, and 10% with active travel and public transport)	Focusing on diesel and older petrol cars, 50% reduction in total car trips (7% replaced with electric light mobility, 18% with car share, and 25% with active travel and public transport)
Vans	All pre-Euro 6 diesel vans replaced with Euro 6d	24% of the non-EV van fleet upgraded to EV (all pre-Euro 6 diesel vans)	Focusing on older vehicles, 20% van fleet replaced with electric light mobility	25% of conventional vans upgraded to EV and 25% replaced with electric light mobility. All remaining vans Euro 6d
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	14% of the non-EV HGV fleet upgraded to EV (all pre-Euro V HGVs)	All pre-Euro VI HGVs upgraded to Euro VI	Double the proportion of EV HGVs, with all remaining HGVs upgraded to Euro VI
L-cat	No change	9% of L-category vehicles Upgraded to EV (all pre-Euro 3 vehicles)	No change to the baseline L-category fleet	All pre-Euro 3 L-category vehicles upgraded to Euro 3-5 (in proportion to baseline distribution)
Buses	No change	Fully electric	No change	Fully electric

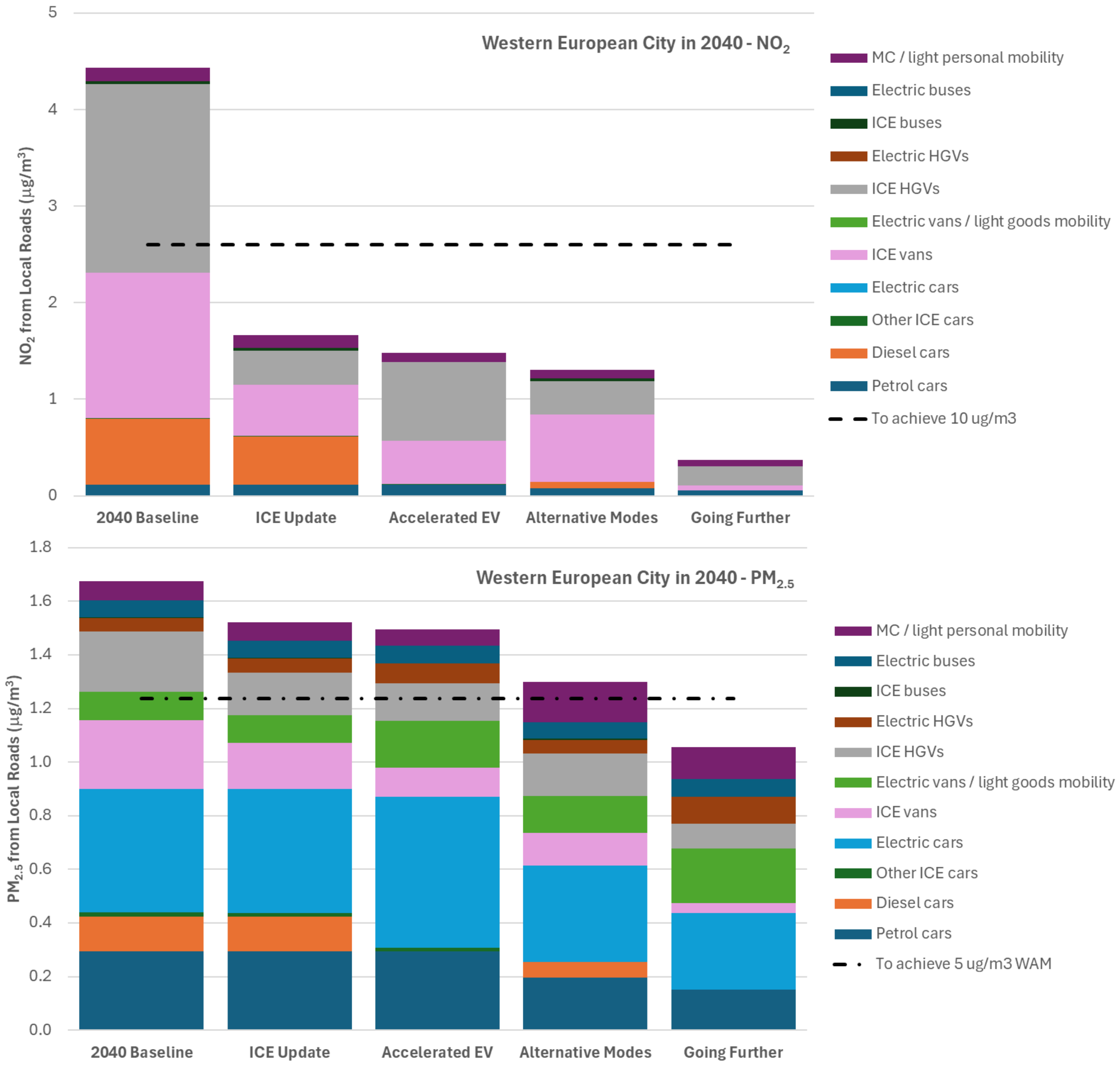


Figure 6-3: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2040 in a 'Typical' Western European City in the Baseline Scenario and with Four Alternative Packages of Interventions

7 Results for the 'Typical' Eastern European City

Current and Future Baseline Concentrations

7.1 Figure 7-1 summarises the predicted baseline concentrations at a roadside monitor within a 'typical' Eastern European city. As explained in Section 2, the roadside concentrations represent the upper quartile across all relevant fixed monitors in Eastern Europe. The background concentrations for 2023 are the means across all relevant fixed monitors in Eastern Europe, forecast forward using the baseline EMEP modelling for the Gothenburg Protocol revision. They do not take account of any of the WAM reductions in Table 3.

7.2 Annual mean NO_2 concentrations are predicted to fall from 32.3 $\mu g/m^3$ in 2023 to 16.9 $\mu g/m^3$ in 2040. Most of this reduction is driven by forecast changes to the local vehicle fleet. Only relatively small reductions in the 'background' component are predicted between 2030 and 2040, which is based on the average trajectory at all relevant background monitors. The limit value of 20 $\mu g/m^3$ is predicted to exceeded in 2030 and achieved in 2040. The WHO guideline of 10 $\mu g/m^3$ is predicted to be exceeded in each year. The 'background' component of concentrations is predicted to take up most of the 10 $\mu g/m^3$ WHO guideline in 2030, meaning that transport emissions would need to reduce to close to zero for the WHO guideline to be achieved in this year unless improvements from other sectors were also achieved. It is, however, noted that the trajectory for future NO_2 concentrations is quite variable across different Eastern European cities and so some locations will see much greater reductions in the 'background' concentrations than others. This is disguised by the average shown in Figure 7-1.

Annual mean $PM_{2.5}$ concentrations are predicted to fall from 17.4 $\mu g/m^3$ in 2023 to 12.7 $\mu g/m^3$ in 2040. This is driven by forecast changes to the 'background' component of concentrations; $PM_{2.5}$ from local road traffic is predicted to increase between 2030 and 2040. This reflects the importance on non-exhaust emissions (principally brake, tyre and road wear) to local $PM_{2.5}$ concentrations and the expectation that total traffic volumes will increase over this period. The limit value of 10 $\mu g/m^3$ is predicted to be exceeded in both 2030 and 2040, as is the WHO target of 5 $\mu g/m^3$. The 'background' component of concentrations alone is predicted to exceed 5 $\mu g/m^3$ in both 2030 and 2040 by a considerable extent, meaning that even the complete removal of all local transport emissions could not achieve the WHO standard in either year without significant additional reductions from other sources. However, as explained above for NO_2, the trajectory for future concentrations is quite variable across different Eastern European cities and so some locations will see much greater reductions in the 'background' concentrations than others. This is disguised by the average shown in Figure 7-1.

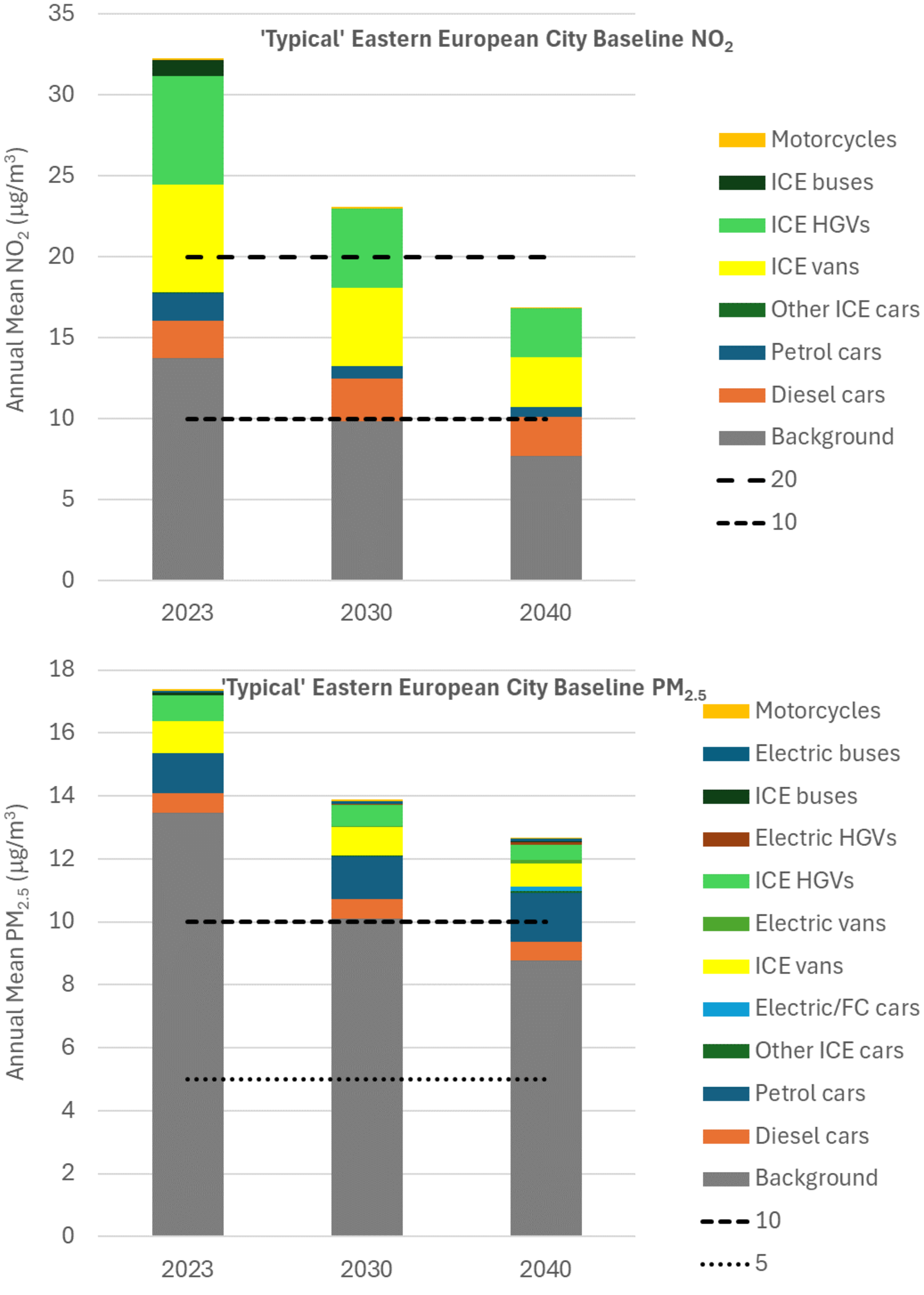


Figure 7-1: Current and Future Baseline NO_2 and $PM_{2.5}$ Concentrations at Worst-case Monitoring Location in a 'Typical' Eastern European City in 2023, 2030 and 2040

Local Transport Interventions

2030

7.3 Table 12 summarises the local transport interventions which have been assessed for the four alternative intervention packages: 'ICE Update', 'Accelerated EV', 'Alternative Modes' and 'Going Further'. Figure 7-2 shows the effect that each of these packages of measures would have on the local road component of concentrations. It also shows (as a dashed line) the local road contribution below which the 20 µg/m³ NO_2 limit value would be achieved and (as dash-dot lines) the local road contributions below which the 10 µg/m³ NO_2 WHO guideline and 10 µg/m³ $PM_{2.5}$ limit value would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. A line for the 5 µg/m³ $PM_{2.5}$ WHO guideline is not shown since its achievement would require such substantial reductions to emissions from non-transport sources that this cannot currently be reliably forecast. Nevertheless, the reductions to traffic-related $PM_{2.5}$ shown in Figure 7-2 would also bring this WHO guideline closer to being achieved.

7.4 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions would all comfortably achieve the 20 µg/m³ NO_2 limit value. The 'Going Further' package of interventions shows what could be achieved using a combination of all available solutions. In this case, the 10 µg/m³ NO_2 WHO guideline and 10 µg/m³ $PM_{2.5}$ limit value could both be achieved, so long as the WAM reductions in Table 3 were also delivered.

Table 12: Summary of Local Transport Interventions Assessed for a 'Typical' Eastern European City in 2030

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 4 cars upgraded to Euro 6d. All pre-Euro 6 diesel cars upgraded to Euro 6d.	30% of the non-EV car fleet upgraded to EV (all pre-Euro 4 petrol and pre-Euro 6 diesel cars, plus 20% of Euro 6a/b conventional diesel cars)	Focusing on older cars (pre-Euro 4) and older diesel cars (pre-Euro 6d-temp) 20% reduction in total car trips (5% replaced with electric light mobility, 10% with car share, and 10% with active travel and public transport)	Focusing on older (pre-Euro 5) and particularly older diesel (pre-Euro 6d Temp) cars, 43% reduction in total car trips (10% replaced with electric light mobility, 20% with car share, and 13% with active travel and public transport)
Vans	All pre-Euro 6 vans upgraded to Euro 6d	35% of the non-EV van fleet upgraded to EV (all pre-Euro 6 diesel vans)	Focusing on older vehicles 36% of van fleet replaced with electric light mobility	9% of conventional vans upgraded to EV and 9% replaced with electric light mobility. All remaining vans Euro 6d
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	22% of the non-EV HGV fleet upgraded to EV (all pre-Euro V HGVs)	All pre-Euro V HGVs upgraded to Euro VI	All pre-Euro VI HGVs upgraded to Euro VI
L-cat	No change	No change	No change to the baseline L-category fleet	No change to the baseline L-category fleet
Buses	No change	No change	No change	No change

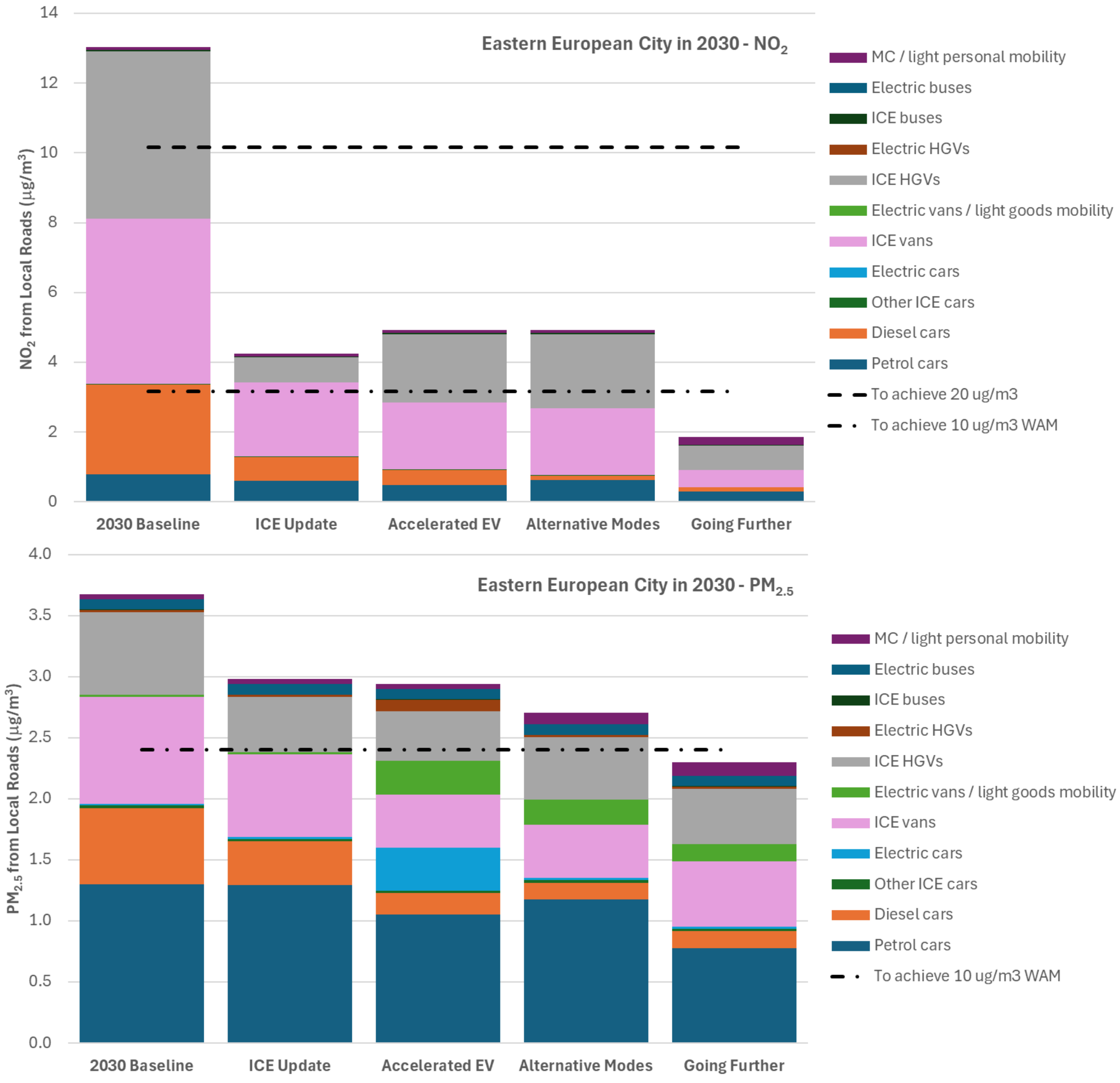


Figure 7-2: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2030 in a 'Typical' Eastern European City in the Baseline Scenario and with Four Alternative Packages of Interventions

2040

7.5 Table 13 summarises the local transport interventions which have been assessed for the four alternative intervention packages. Figure 7-3 shows the effect that each of these packages of measures would have on the local road component of concentrations. It also shows (as a dashed line) the local road contributions below which the 10 $\mu g/m^3$ NO_2 WHO guideline would be achieved. Finally, it shows (as a dash-dot line) the local road contributions below which the 10 $\mu g/m^3$ $PM_{2.5}$ limit value would be achieved if the illustrative WAM reductions to non-transport sources in Table 3 were also delivered. A line for the NO_2 limit value is not shown since it is predicted to be achieved in 2040 even without any local transport interventions. A line for the 5 $\mu g/m^3$ $PM_{2.5}$ WHO guideline is not shown since its achievement would require such substantial reductions to emissions from non-transport sources that this cannot currently be reliably forecast. Nevertheless, the reductions to traffic-related $PM_{2.5}$ shown in Figure 7-3 would also bring this WHO guideline closer to being achieved.

7.6 The 'ICE Update', 'Accelerated EV', and 'Alternative Modes' packages of interventions would all achieve the 10 µg/m³ NO_2 WHO guideline using alternative solutions. The 'Going Further' package of interventions shows what could be achieved using a combination of all available approaches. If the WAM reductions in Table 3 were also delivered, both the 'Alternative Modes' and 'Going Further' packages of interventions would also allow attainment of the $PM_{2.5}$ limit value.

Table 13: Summary of Local Transport Interventions Assessed for a 'Typical' Eastern European City in 2040

	ICE Update	Accelerated EV	Alternative Modes	Going Further
Cars	All pre-Euro 6 cars upgraded to Euro 6d. All pre-Euro 6 d-temp diesel cars upgraded to Euro 6d	14% of the non-EV car fleet upgraded to EV (all pre-Euro 6 d-temp diesel cars).	Focusing on older (pre-Euro 6 d-temp) diesel cars and pre-Euro 6 petrol cars, 26% reduction in total car trips (10% replaced with electric light mobility, 6% with car share, and 10% with active travel and public transport)	Focusing on diesel and older petrol cars, 40% reduction in total car trips (15% replaced with electric light mobility, 15% with car share, and 20% with active travel and public transport)
Vans	All pre-Euro 6d-temp vans upgraded to Euro 6d	34% of the non-EV van fleet upgraded to EV (all pre-Euro 6d-temp diesel vans)	Focusing on older diesel vehicles, 26% van fleet replaced with electric light mobility	15% of conventional vans upgraded to EV and 5% replaced with electric light mobility. All remaining vans Euro 6d
HGVs	All pre-Euro VI HGVs upgraded to Euro VI	21% of the non-EV HGV fleet upgraded to EV (all pre-Euro VI HGVs)	All pre-Euro VI HGVs upgraded to Euro VI	10% of HGVs upgraded to EV. All remaining HGVs Euro VI
L-cat	No change	No change	No change to the baseline L-category fleet	No change to the baseline L-category fleet
Buses	No change	Fully electric	No change	Fully electric

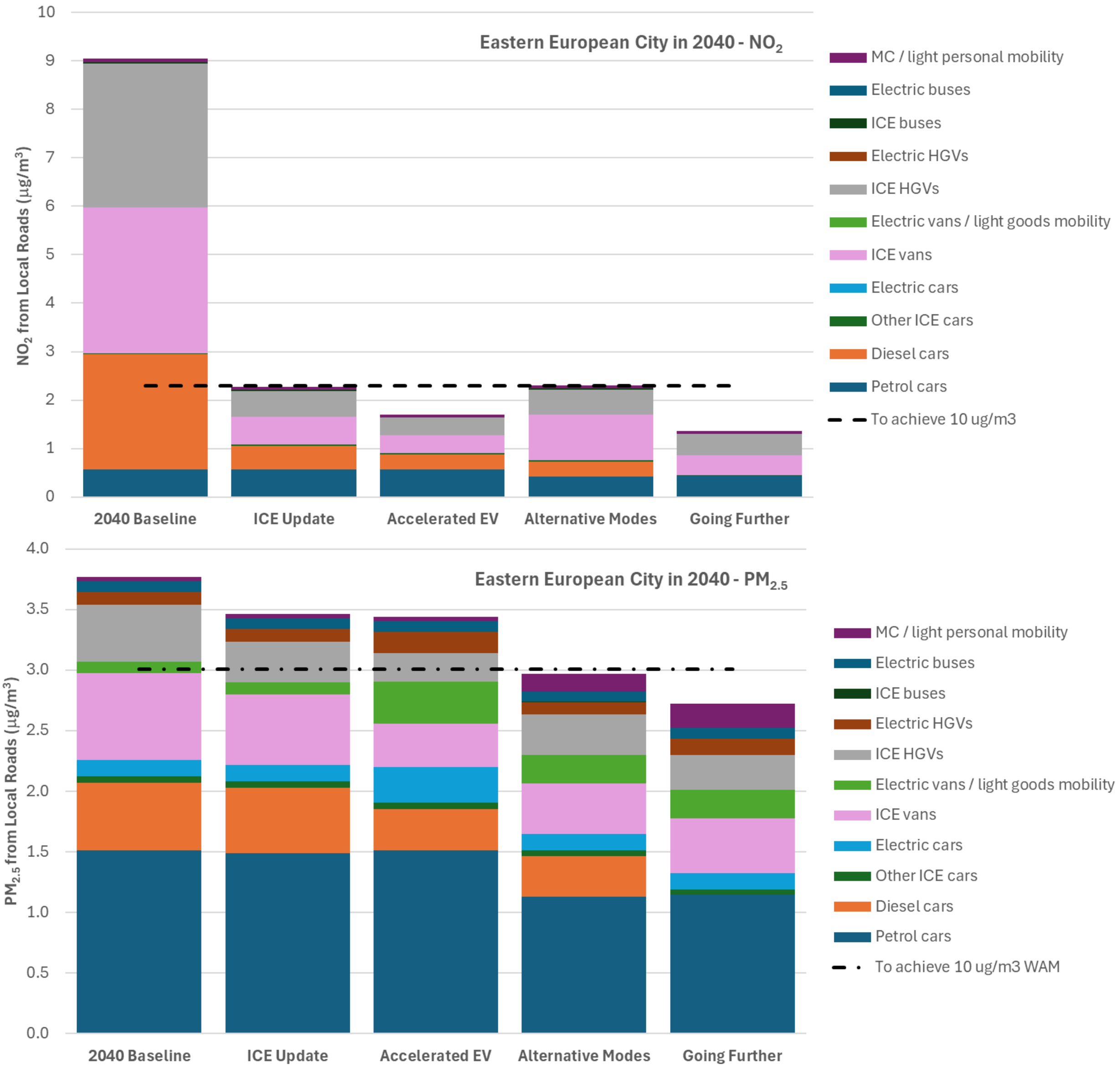


Figure 7-3: NO_2 and $PM_{2.5}$ Concentrations from Local Roads in 2040 in a 'Typical' Eastern European City in the Baseline Scenario and with Four Alternative Packages of Interventions

8 Summary and Conclusions

8.1 This report has defined sets of transport interventions which would allow cities to achieve the new air quality limit values and WHO guidelines for NO_2 and $PM_{2.5}$. This has been done for both 2030 and 2040 at worst-case locations in:

- Paris;
- Milan; and
- Warsaw.

8.2 In addition, measurements from across Europe have been used to characterise worst-case roadside air quality in 'typical' cities within:

- Western Europe; and
- Eastern Europe.

8.3 A variety of measures are available to reduce the effects of local road traffic on concentrations of NO_2 and $PM_{2.5}$. This report has shown how the targeted application of packages of measures will allow significantly improved air quality at worst-case roadside locations. This, in turn, will allow the earlier attainment of limit values and WHO guidelines than would otherwise be possible.

8.4 Table 14 summarises the air quality standards which could be achieved in each city and in each year using the measures set out in this report. The precise package of transport measures differs for each city and depends on the desired outcome with respect to targeting limit values or WHO guidelines in a given year. In many cases, action on local road transport would need to be combined with improvements to other sectors in order to achieve both the limit values and WHO guidelines. This report has only considered in detail actions to reduce emissions from road transport but has shown how interventions to local transport policy can bring about significantly improved local air quality and play an important part to achieving both the limit values and WHO guidelines.

Table 14: Summary of Air Quality Standards Which Can be Achieved by City and by Year

Pollutant	**NO_2**		**$PM_{2.5}$**	
Concentration standard	**20**	**10**	**10**	**5**
2030				
Paris	Y	W	A	W
Milan	Y	W	W	N
Warsaw	Y	N	Y	N
Typical Western European City	A	Y	A	W
Typical Eastern European City	Y	W	W	N
2040				
Paris	A	Y	A	W
Milan	A	Y	W	N
Warsaw	Y	W	Y	W
Typical Western European City	A	Y	A	W
Typical Eastern European City	A	Y	W	N

• The air quality standard is already forecast to be achieved without any local traffic interventions.	A
• The air quality standard could be achieved using the local transport measures presented in this report.	Y
• The air quality standard could be achieved by combining the packages of local transport measures presented in this report with achievable reductions from other sectors.	W
• Achieving this standard would require greater ambition, across a broader range of sectors, than it has been possible to quantify in this report.	N

9 Appendices

A1 Existing Baseline Concentrations at Worst-case Fixed Monitors and the Contributions from Other Sources

A1.1 The worst-case fixed monitoring sites in Paris, Milan and Warsaw used in this study are the same as used in previous work[4]. The current study has updated the measurements to present a 2023 baseline. For ease of reading, all the monitoring locations, and the approach to calculating local road increments to concentrations, are described below.

A1.2 The approach to calculating baseline concentrations in the 'typical' Eastern and Western European cities is described in Paragraphs A1.20 to A1.31.

Greater Paris

NO_2 in Greater Paris

A1.3 Figure A1-1 shows the annual mean concentrations measured at all sites in Greater Paris since 2013. It highlights the monitor which has recorded the highest concentrations in most years, including 2023 (Auto A1 - Saint Denis), and four background monitors which are close to the Auto A1 site. The locations of these sites are shown in Figure A1-2. The location of the Auto A1 site is shown in more detail in Figure A1-3.

A1.4 Table A1-1 summarises the measured annual mean NO_2 concentrations in 2023 at these five sites and shows how the local road increment has been calculated. The closest background monitor to the Auto A1 site is the Saint Denis background monitor. However, this site did not achieve sufficient data capture during 2023 to be used in the current study. Figure A1-1 shows that, historically, NO_2 concentrations measured at Gennevilliers and Bobigny were similar to those at the Saint Denis background site. The contribution from other sources in 2023 has therefore been taken as the average concentration measured at Gennevilliers and Bobigny. This suggests that local roads contributed 55% to the total measured concentration at the Auto A1 - Saint Denis site.

A1.5 The road increment shown in Table A1-1 has been taken to represent the local road contribution to NO_2 concentrations, while the 'Background to Use' value has been taken to represent the contribution from all other sources in 2023.

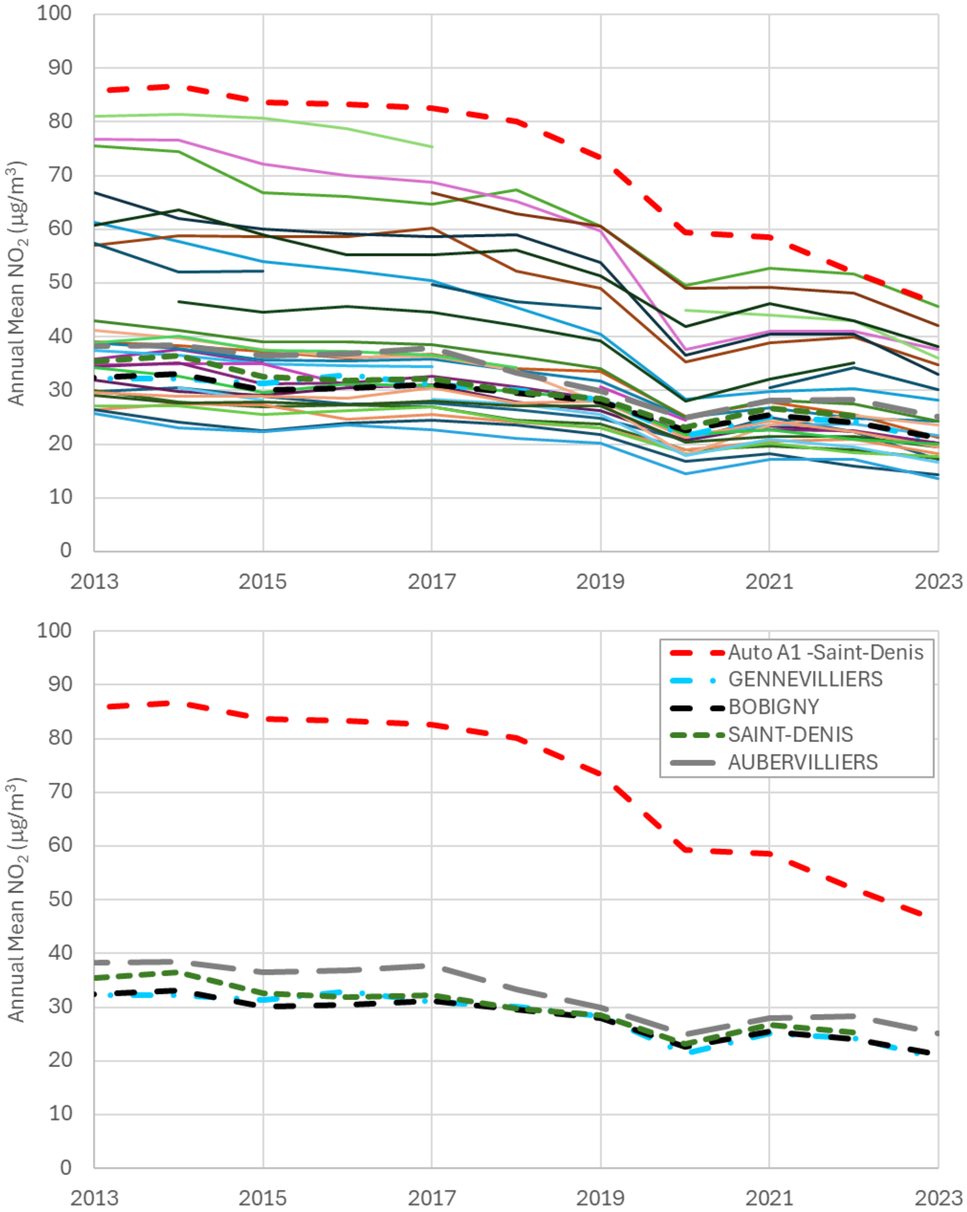


Figure A1-1: Annual Mean NO₂ Concentrations at Fixed Monitoring Sites in Paris, 2013 to 2023 – Highlighting Five Sites of Particular Relevance

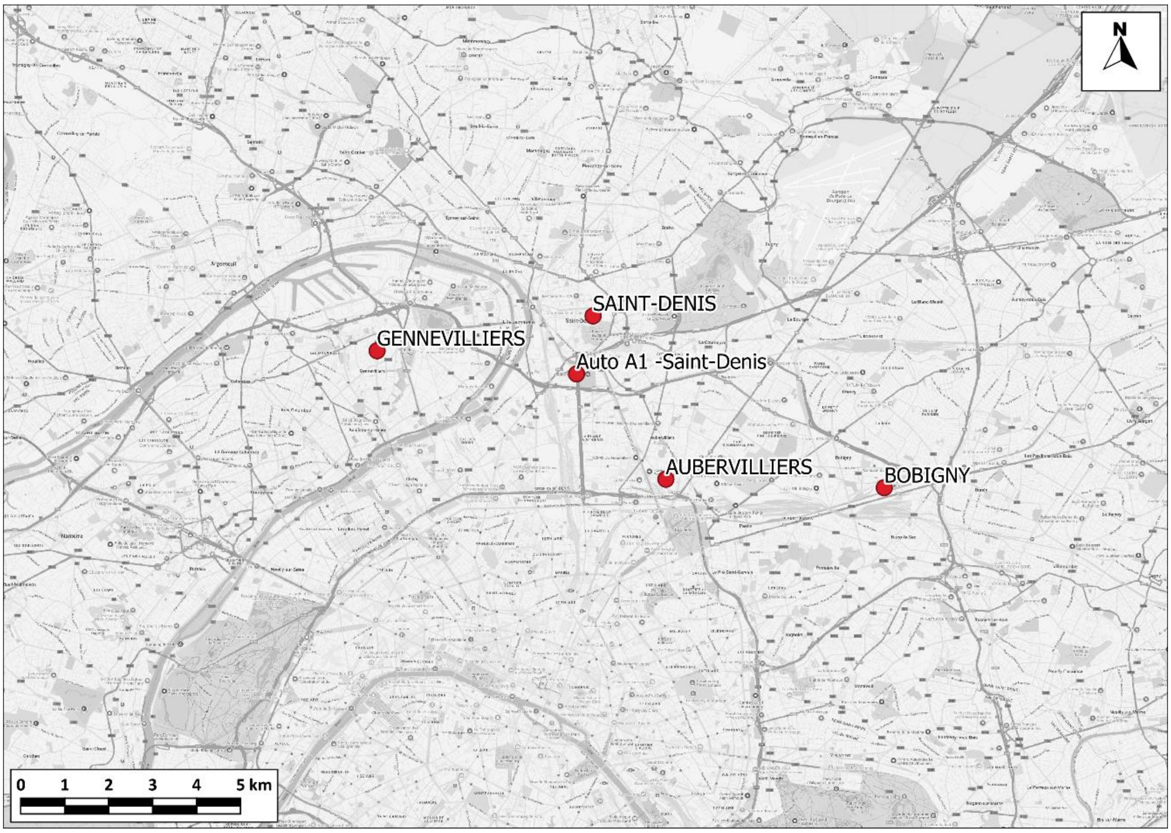


Figure A1-2: Locations of Five Monitoring Sites in Greater Paris

Map data ©2024 Google

Table A1-1: Baseline Annual Mean NO_2 Concentrations in 2023 - Paris

Monitoring Site	Annual Mean NO_2 (µg/m³)
Roadside Total	
Auto A1 – Saint Denis	46.1
Background	
GENNEVILLIERS	20.6
BOBIGNY	21.2
SAINT-DENIS	-
AUBERVILLIERS	25.2
(Background to Use)	*(20.9)*
Road Increment (Roadside total minus background – calculated from unrounded numbers)	
Auto A1 – Saint Denis	25.2

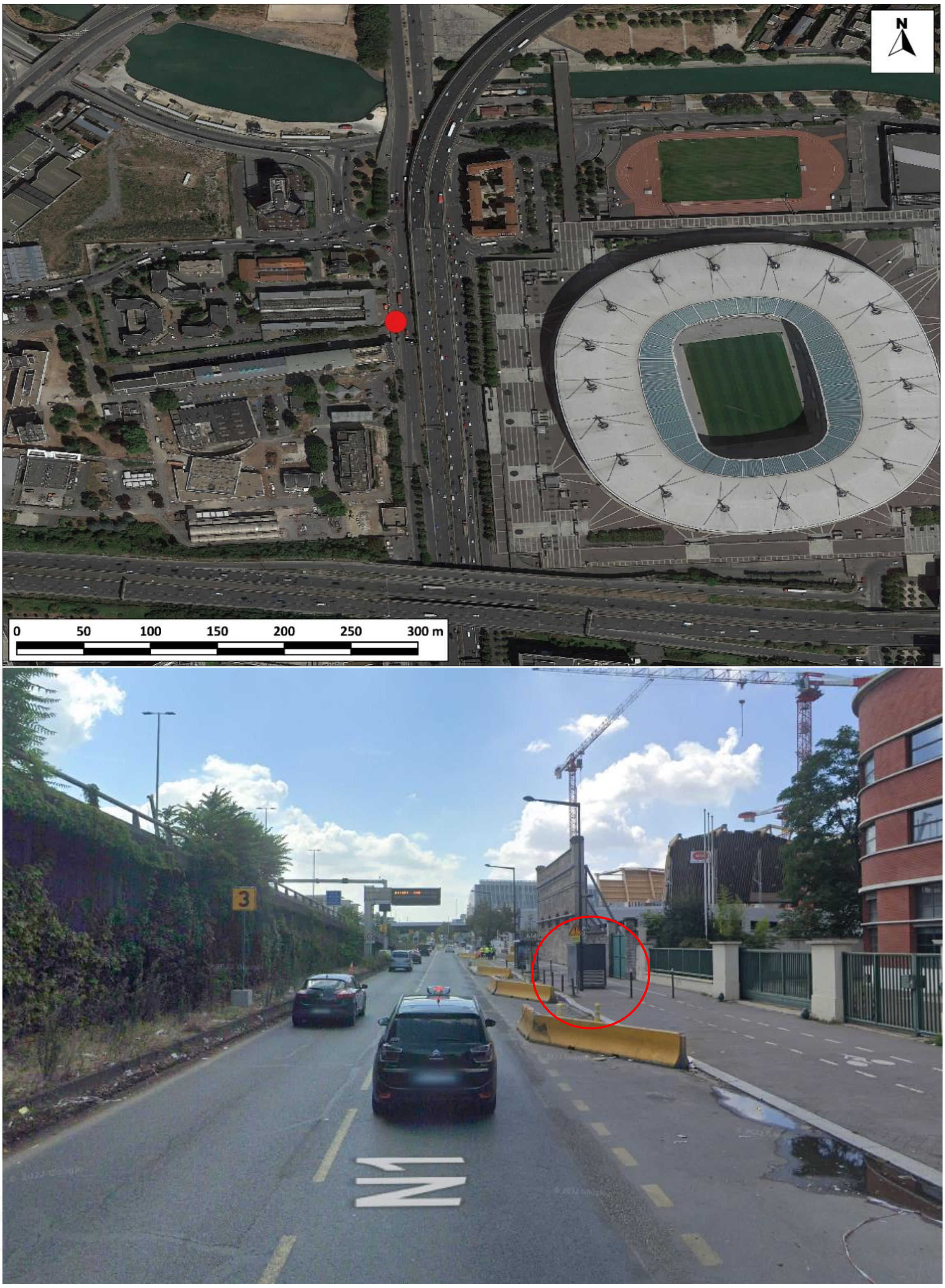


Figure A1-3: Auto A1 - Saint Denis Monitoring Station, Paris

Imagery ©2024 Aerodata International Surveys, CNES/Airbus, Maxar Technologies, The GeoInformation Group InterAtlas, Map data ©2024 Google.

A1.6 The EMEP modelling referred to in this study[13] predicts concentrations on a grid which is approximately 10 km x 10 km. The surface level NO_2 concentrations using 2015 meteorological data (in parts per billion 'ppb') for the grid cell in which the Auto A1 monitor lies are shown in Table A1-2. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the EMEP model predictions suggest that background NO_2 concentrations at the Auto A1 site will fall by 43% between 2023 and 2030 and by a further 31% between 2030 and 2040. Applying these percentage reductions to the 'background to use' value in Table A1-1, gives the year-specific background concentrations in Table A1-3. The values in Table A1-3 have been used in this study.

Table A1-2: Modelled Background NO_2 Concentration (in ppb) based on 2015 Meteorology for the Area Around the Auto A1 Site in Paris[13]

2015	2030	2050
31.4	12.0	4.5

Table A1-3: Predicted Background NO_2 Concentrations at the Auto A1 Site in Paris ($\mu g/m^3$)

2023	2030	2040
20.9	11.9	8.2

$PM_{2.5}$ in Greater Paris

A1.7 Figure A1-4 summarises the measured annual mean $PM_{2.5}$ concentrations at fixed monitoring sites in Paris as reported to the European Commission. The measurements for the Auto A1 site, Genneviliers and Bobigny sites are highlighted (see Figure A1-2, above, for monitor locations). In 2023, two sites measured higher $PM_{2.5}$ concentrations than the Auto A1 station (Bld peripherique Est (13.2 $\mu g/m^3$) and RN20 – Montlhery (12.9 $\mu g/m^3$)). However, the study has focused on the Auto A1 station (which measured 12.7 $\mu g/m^3$) owing to its long-standing position as the worst-case monitor over many years for both NO_2 and $PM_{2.5}$ and for consistency with previous work.

A1.8 Table A1-4 shows $PM_{2.5}$ concentrations in 2023 at the Auto A1 station and two most representative background monitors. It also shows how the local road increment has been calculated. The Saint Denis background monitor does not measure $PM_{2.5}$. As with NO_2, the contribution from other sources at the Auto A1 station has been taken as the average of that measured at Bobigny and Gennevilliers. This suggests that local roads contributed 26% to the total measured concentration at the Auto A1 site.

A1.9 The surface level $PM_{2.5}$ concentrations predicted in the EMEP modelling using 2015 meteorological data for the grid cell in which the Auto A1 monitor lies are shown in Table A1-5. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the EMEP model predictions suggest that background $PM_{2.5}$ concentrations at the Auto A1 site will fall by 24% between 2023 and 2030 and by a further 8% between 2030 and 2040. Applying these percentage reductions to the 'background to use' value in Table A1-4 gives the year-specific background concentrations in Table A1-6. The values in Table A1-6 have been used in this study.

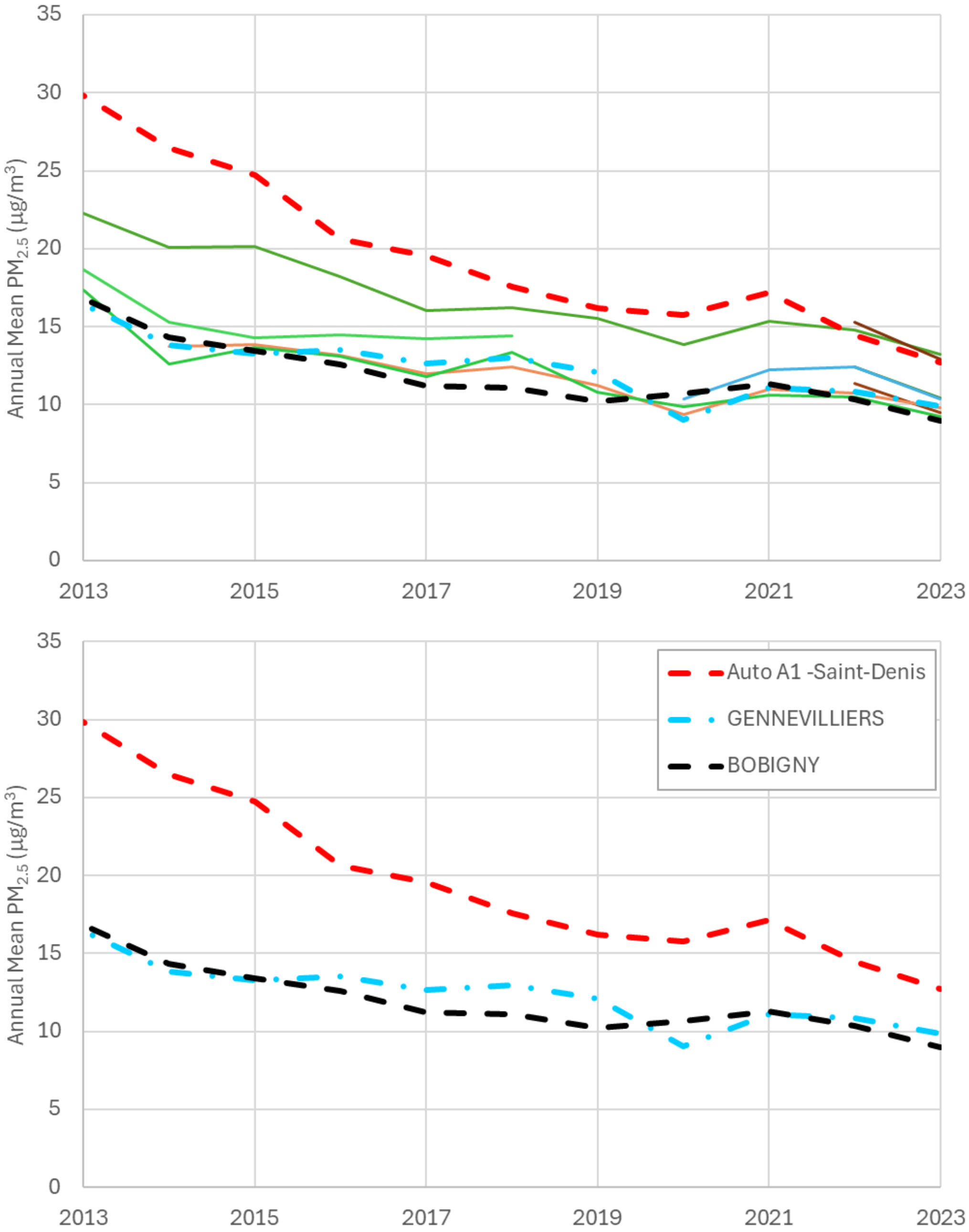


Figure A1-4: Annual Mean $PM_{2.5}$ Concentrations at Fixed Monitoring Sites in Paris, 2013 to 2023 – Highlighting Three Sites of Particular Relevance

Table A1-4: Baseline Annual Mean $PM_{2.5}$ Concentrations in 2023 - Paris

Monitoring Site	Annual Mean $PM_{2.5}$ ($\mu g/m^3$)
Roadside Total	
Auto A1 – Saint Denis	12.7
Background	
GENNEVILLIERS	9.9
BOBIGNY	9.0
(Background to Use)	*(9.4)*
Road Increment (Roadside total minus background – calculated from unrounded numbers)	
Auto A1 – Saint Denis	3.3

Table A1-5: Modelled Background $PM_{2.5}$ based on 2015 Meteorology for the Area Around the Auto A1 Site in Paris ($\mu g/m^3$)[13]

2015	2030	2050
11.2	6.7	5.6

Table A1-6: Predicted Background $PM_{2.5}$ Concentrations at the Auto A1 Site in Paris ($\mu g/m^3$)

2023	2030	2040
9.4	7.2	6.6

Milan

NO_2 in Milan

A1.10 Figure A1-5 shows the annual mean concentrations measured at all sites in Milan since 2013. It highlights the monitor which has recorded the highest concentrations in most years, including 2023 (Viale Marche), and a nearby site which is labelled as representing background conditions. The locations of these sites are shown in Figure A1-6. The location of the Viale Marche site is shown in more detail in Figure A1-7.

A1.11 Advice from a local Clean Cities Campaign (CCC) coordinator was that the Citta Studi site does not provide a good representation of local background concentrations and is itself likely to be significantly influenced by local emissions sources. However, there are no other suitable monitoring sites which could provide a robust indication of the contribution from other sources. For Milan, an alternative approach has been taken to apportion the concentration measured at the roadside monitor. The official emissions inventory for the city, provided by CCC, suggests that road transport contributes 63% of the total NOx emissions in Milan. The total measured NO_2 concentration in 2023 has been multiplied by 0.63 to estimate the traffic component. Table A1-7 shows how the NO_2 concentration measured in 2019 at the Viale Marche monitoring site has been apportioned.

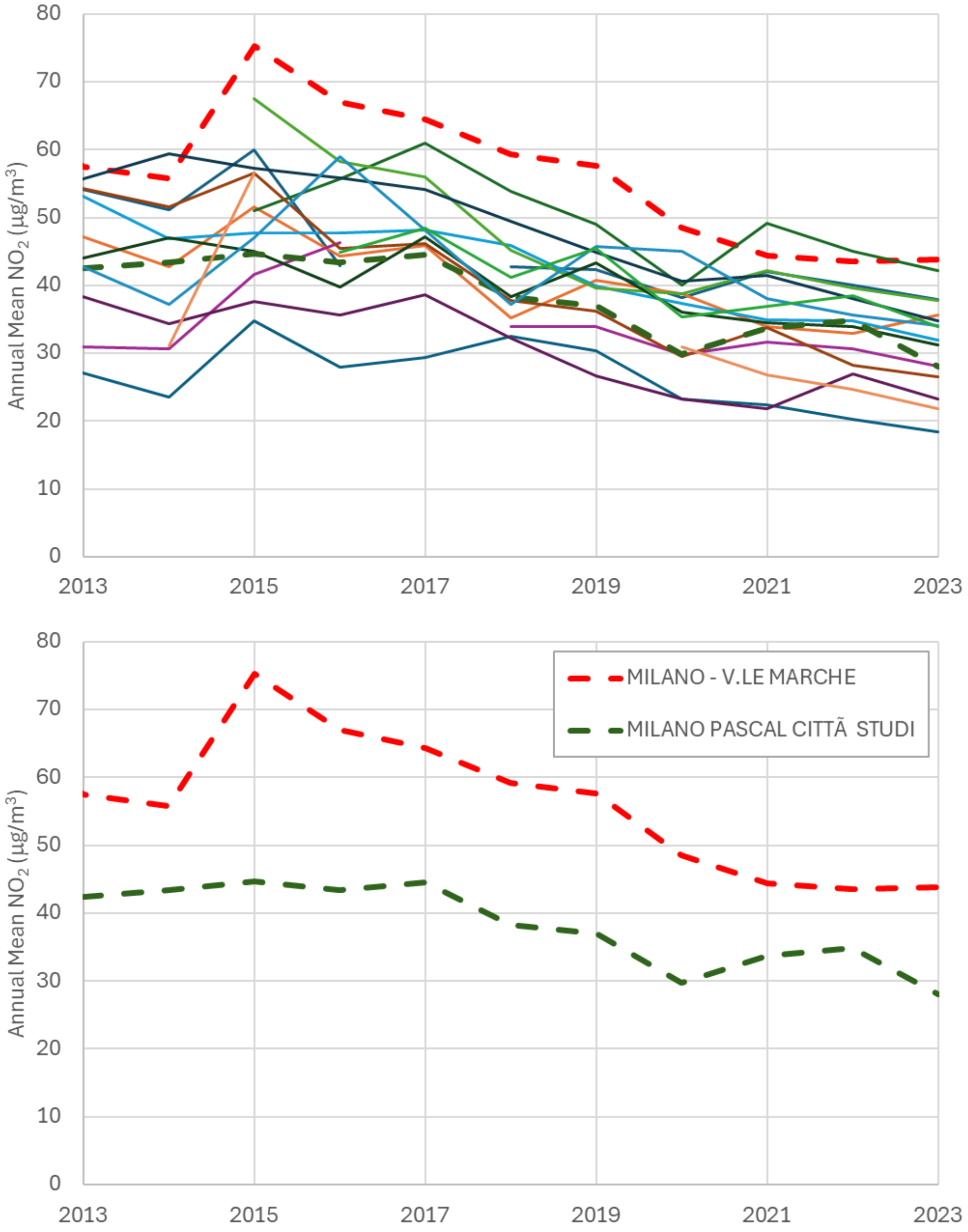


Figure A1-5: Annual Mean NO_2 Concentrations at Fixed Monitoring Sites in Milan, 2013 to 2023 – Highlighting Two Sites of Particular Relevance

A1.12 The EMEP modelling referred to in this study[13] predicts concentrations on a grid which is approximately 10 km x 10 km. The surface level NO_2 concentrations using 2015 meteorological data for the grid cell in which the Viale Marche monitor lies are shown in Table A1-8. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the EMEP model predictions suggest that background NO_2 concentrations at the Viale Marche site will fall by 41% between 2023 and 2030 and by a further 27% between 2030 and 2040. Applying these percentage reductions to the 'contribution from other sources' value in Table A1-7, gives the year-specific background concentrations in Table A1-9. The values in Table A1-9 have been used in this study.

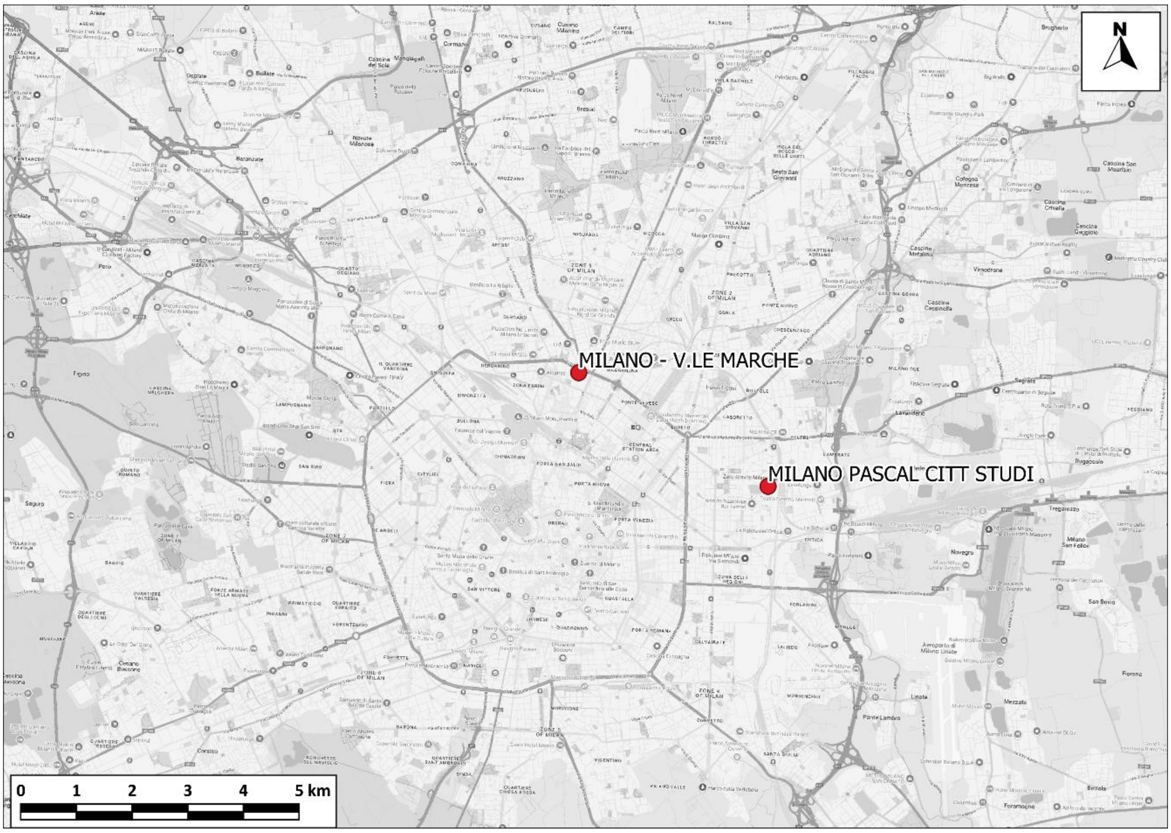


Figure A1-6: Locations of Two NO_2 Monitoring Sites in Milan

Map data ©2024 Google

Table A1-7: Apportioning the 2023 Measured NO_2 Concentration at the Viale Marche Site in Milan

Description	Value
Roadside Total (µg/m^3)	43.8
Contribution of Road Transport to City Total Emissions %	63%
Contribution from Road Traffic (µg/m^3)	27.6
Contribution from Other Sources (µg/m^3)	16.2

Table A1-8: Modelled Background NO_2 (in ppb) based on 2015 Meteorology for the Area Around the Viale Marche Site in Milan[13]

2015	2030	2050
17.7	7.1	3.2

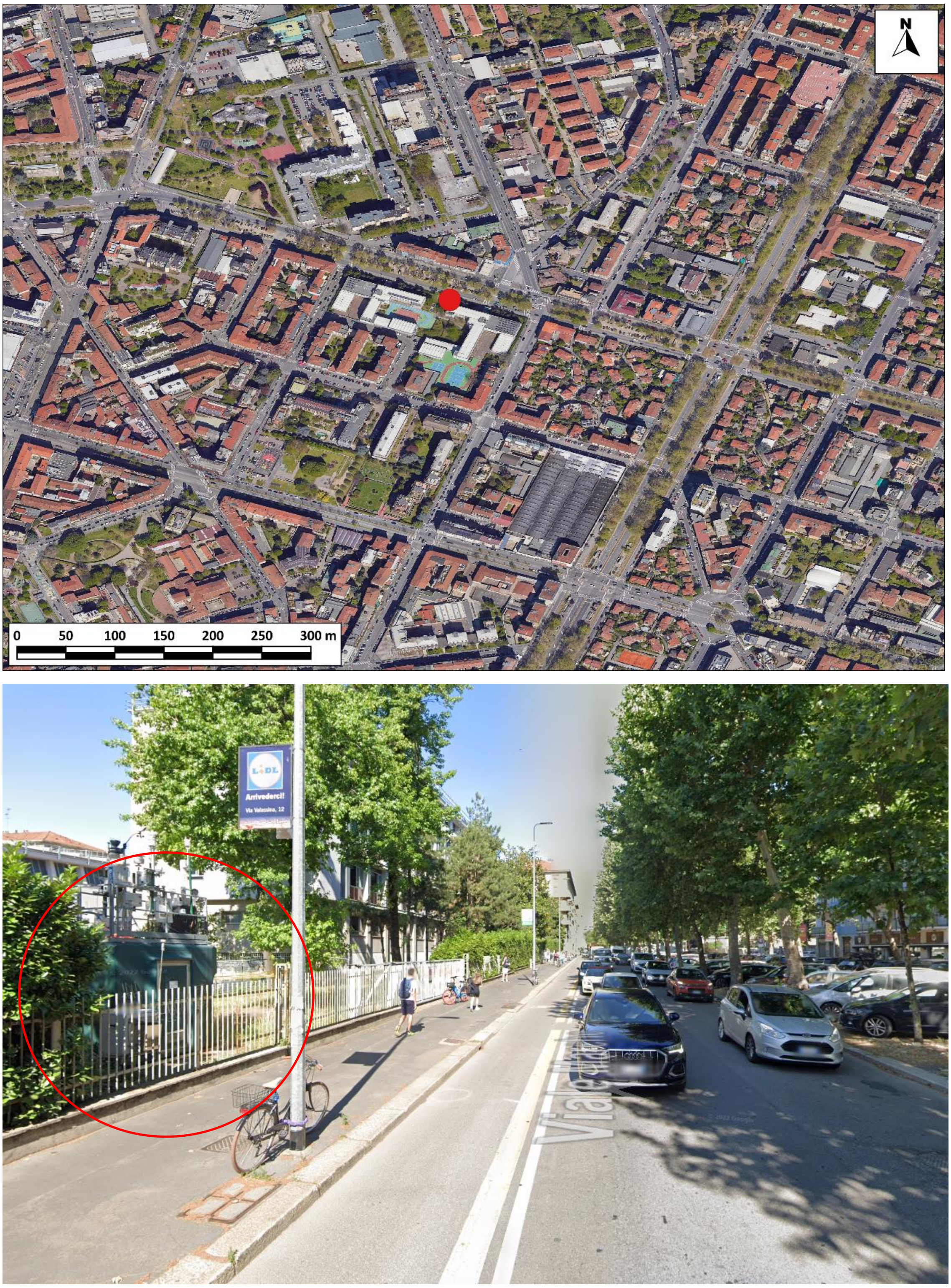


Figure A1-7: Viale Marche Monitoring Station, Milan

Imagery ©2024 CNES/Airbus, Maxar Technologies, Terra Bella Map data ©2023 Google.

Table A1-9: Predicted Background NO_2 Concentrations at the Viale Marche Site in Milan (µg/m³)

2023	2030	2040
16.2	9.6	6.9

$PM_{2.5}$ in Milan

A1.13 Figure A1-8 summarises the measured annual mean $PM_{2.5}$ concentrations in 2023 at the fixed monitoring sites in Milan as reported to the European Commission. $PM_{2.5}$ was not measured at the Viale Marche site. The two sites with long-term data which are labelled as roadside are Sesto S. Giovanni and Milano Senato. Monza via Machiavelli is labelled as a background site. Given the NO_2 concentrations measured, it seems likely that if $PM_{2.5}$ were measured at Viale Marche, the road component of concentrations would be elevated. The approach has been to scale the road-component of NO_2 measured at Viale Marche by the ratio of measured road-$PM_{2.5}$: road-NO_2 at the Auto A1 station in Paris. The contribution from other sources is then taken to be the $PM_{2.5}$ concentration measured at the Citta Studi site. This calculation is shown in Table A1-10. This is the approach which was taken for $PM_{2.5}$ in Milan in the previous study[4] and takes account of local advice from CCC. For this reason, the same approach has also been followed here. While it is noted that the total calculated $PM_{2.5}$ concentration in Table A1-10 (19.6 µg/m³) is lower than that measured at Milano Senato (21.2 µg/m³), the temporal profile in the Senato data appears to be unusual and little is known about this monitor and its siting. The study has, therefore, followed the approach agreed previously and therefore focused on the inferred concentration at Viale Marche given in Table A1-10.

Table A1-10: Estimating the Road-$PM_{2.5}$ Concentration at the Viale Marche Monitoring Site in Milan

Description	Value
road $PM_{2.5}$: road-NO_2 ratio in Paris	0.13
Calculated road-NO_2 at Viale Marche (µg/m³)	27.6
Calculated road-$PM_{2.5}$ at Viale Marche (µg/m³)	3.6
Contribution from Other Sources (µg/m³)	16.0
Estimated total $PM_{2.5}$ Concentration at Viale Marche (µg/m³)	19.6

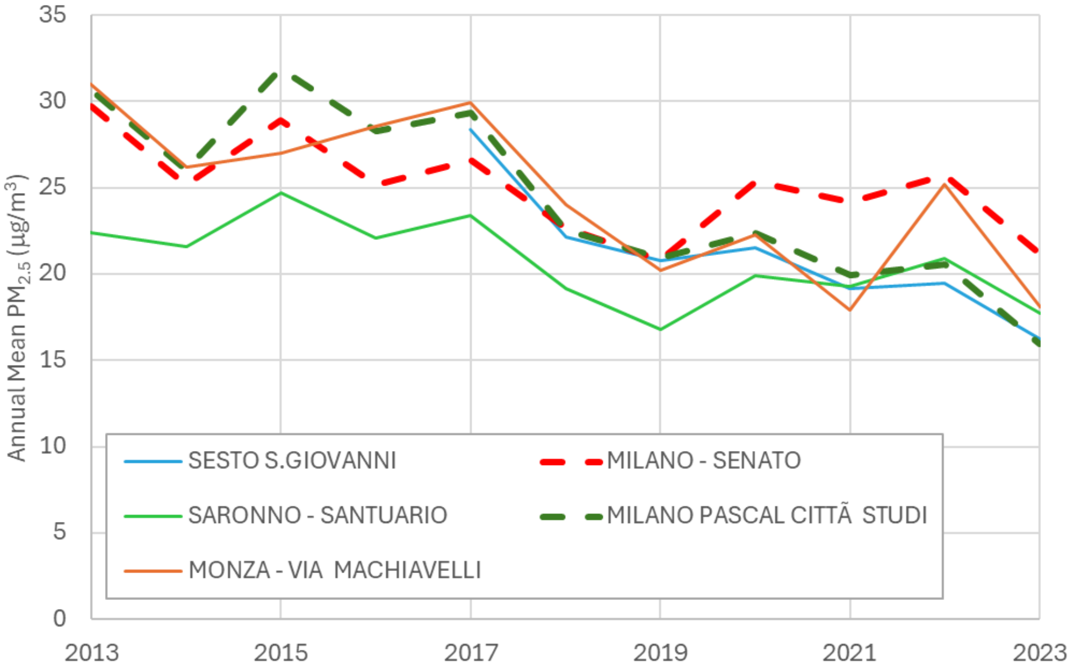


Figure A1-8: Annual Mean $PM_{2.5}$ Concentrations at Fixed Monitoring Sites in Milan, 2013 to 2023 – Highlighting Two Sites of Potential Relevance

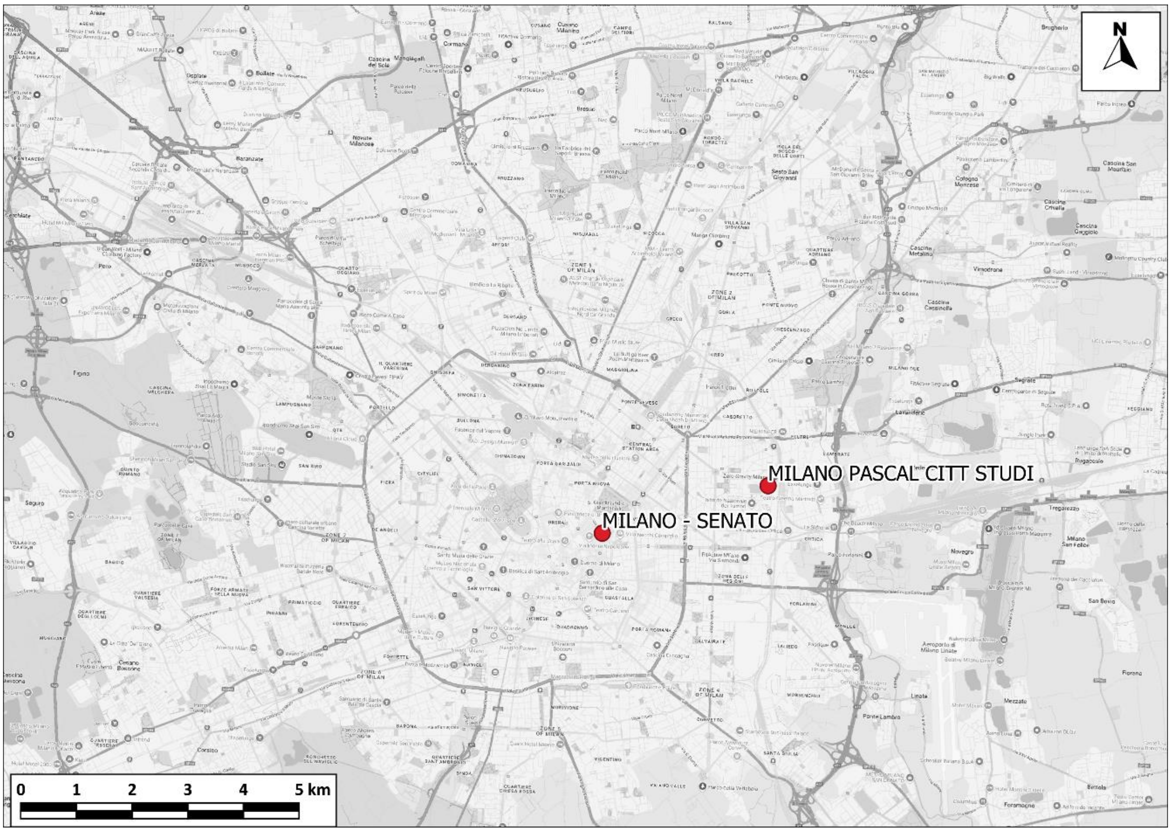


Figure A1-9: Locations of Two $PM_{2.5}$ Monitoring Sites in Milan

Map data ©2024 Google

A1.14 The surface level $PM_{2.5}$ concentrations predicted in the EMEP modelling using 2015 meteorological data for the grid cell in which the Viale Marche monitor lies are shown in Table A1-11. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the EMEP model predictions suggest that background $PM_{2.5}$ concentrations at the Viale Marche monitor will fall by 28% between 2023 and 2030 and by a further 16% between 2030 and 2040. Applying these percentage reductions to the 'contribution from other sources' value in Table A1-10 gives the year-specific background concentrations in Table A1-12. The values in Table A1-12 have been used in this study.

Table A1-11: Modelled Background $PM_{2.5}$ based on 2015 Meteorology for the Area Around the Viale Marche Site in Milan (µg/m³)[13]

2015	2030	2050
24.9	13.5	9.2

Table A1-12: Predicted Background $PM_{2.5}$ Concentrations at the Viale Marche Site in Milan (µg/m³)

2023	2030	2040
16.0	11.4	9.6

Warsaw

NO_2 in Warsaw

A1.15 Figure A1-10 shows the annual mean concentrations measured at all sites in Warsaw since 2013. It highlights the monitor which has recorded the highest concentrations in most years, including 2023 (al. Niepodleglosci). The ul. Wokalna background site is considered the most well sited, at nearly 200 m from the nearest main road but within an urban area, and so has been used to represent background conditions. While data from ul. Wokalna appear in Figure A1-10 to have ended in 2021, the site reported good data capture in 2023 (99%) and measured an annual mean NO_2 concentration of 16.8 µg/m³. The locations of these sites are shown in Figure A1-11. The location of the al. Niepodleglosci site is shown in more detail in Figure A1-12.

A1.16 Table A1-13 sets out how the local road increment has been calculated for Warsaw. The road increment shown in Table A1-13 has been taken to represent the local road contribution to NO_2 concentrations, while the 'Background to Use' value has been taken to represent the contribution from all other sources.

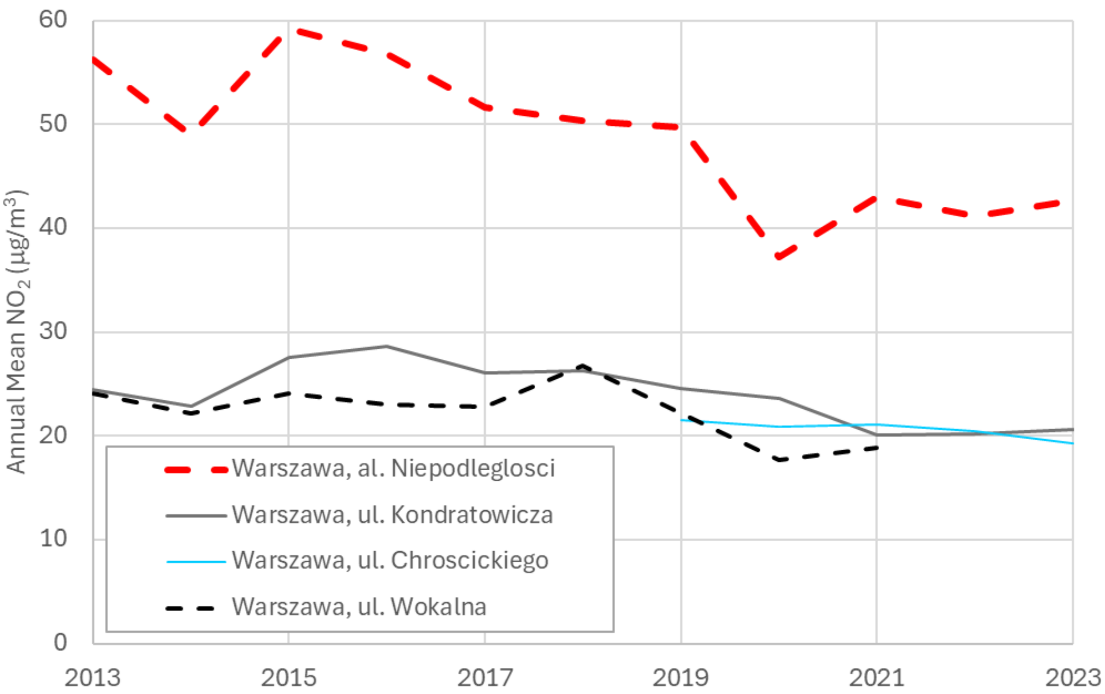


Figure A1-10: Annual Mean NO_2 Concentrations at Fixed Monitoring Sites in Warsaw, 2013 to 2023

Table A1-13: Baseline Annual Mean NO_2 Concentrations in 2023 - Warsaw

Monitoring Site	Annual Mean NO_2 (µg/m³)
Roadside Total	
al. Niepodleglosci	42.7
Background	
ul. Kondratowicza	20.7
ul. Wokalna	16.8
Ul. Chroscickiego	19.3
(Background to Use)	*(16.8)*
Road Increment (Roadside total minus background – calculated from unrounded numbers)	
al. Niepodleglosci	25.8

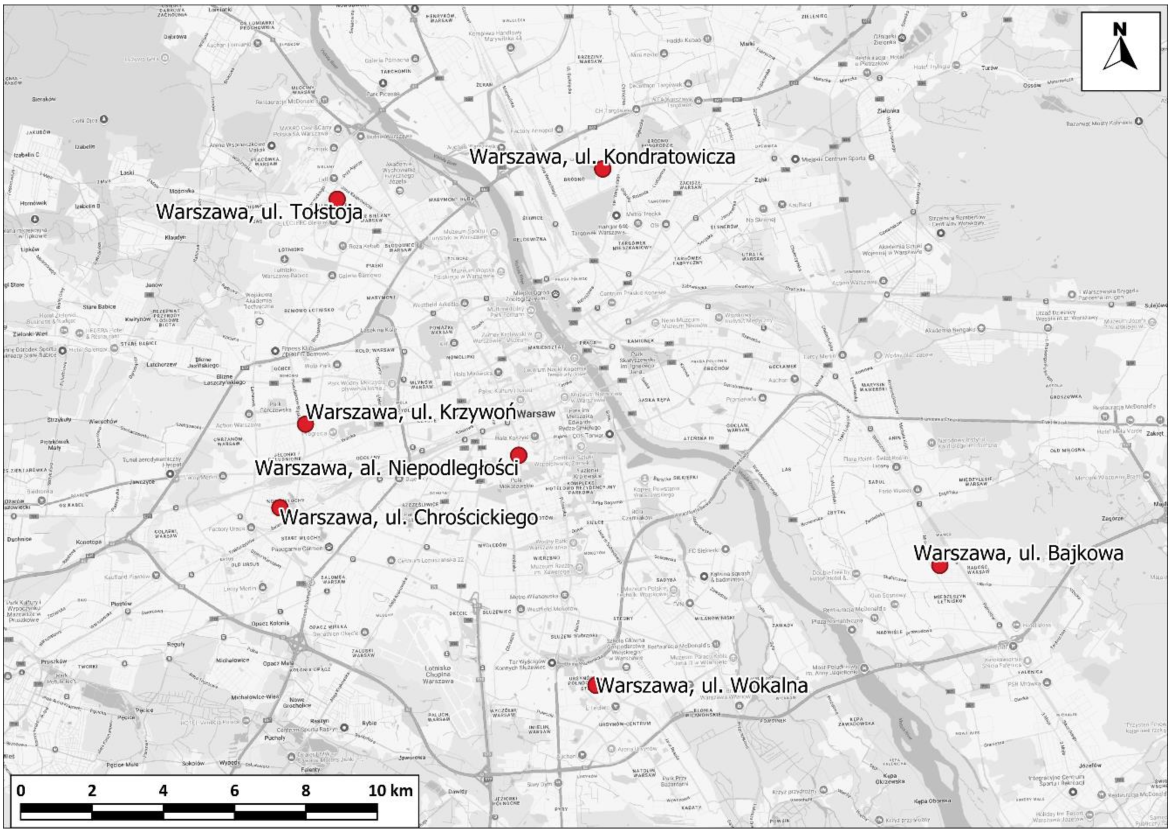


Figure A1-11: Locations of NO_2 and $PM_{2.5}$ Monitoring Sites in Warsaw

Map data ©2024 Google.

A1.17 The EMEP modelling referred to in this study[13] predicts concentrations on a grid which is approximately 10 km x 10 km. The surface level NO_2 concentrations using 2015 meteorological data for the grid cell in which the al. Niepodleglosci monitor lies are shown in Table A1-14. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the EMEP model predictions suggest that background NO_2 concentrations at the al. Niepodleglosci site will fall by 23% between 2023 and 2030 and by a further 17% between 2030 and 2040. Applying these percentage reductions to the 'background to use' value in Table A1-13, gives the year-specific background concentrations in Table A1-15. The values in Table A1-15 have been used in this study.

Table A1-14: Modelled Background NO_2 Concentration (in ppb) based on 2015 Meteorology for the Area Around the al. Niepodleglosci Site in Warsaw[13]

2015	2030	2050
6.1	3.7	2.5

Table A1-15: Predicted Background NO_2 Concentrations at the al. Niepodleglosci Site ($\mu g/m^3$)

2023	2030	2040
16.8	13.0	10.8

Figure A1-12: al. Niepodleglosci Monitoring Station, Warsaw

Imagery ©2024 CNES/Airbus, Maxar Technologies, MGGP Aero, Maxar Technologies, Map data ©2023 Google.

$PM_{2.5}$ in Warsaw

A1.18 Figure A1-13 shows the annual mean concentrations measured at all sites in Warsaw since 2013. The locations of these sites are shown in Figure A1-11, above. Figure A1-13 highlights the monitor which has recorded the highest concentrations in most years (al. Niepodleglosci). While the monitoring sites at Chroscickiego and Bajkowa measured higher concentrations in 2023, both sites are officially classified as background stations and are not in the centre of Warsaw. To retain consistency with the previous study[4], the approach has been to first calculate the local contribution to NOx concentrations at al. Niepodleglosci using the same sites and method described for NO_2. The traffic emissions model for Warsaw has then been used to calculate the average ratio between traffic emissions of NOx and $PM_{2.5}$. The local road component of NOx has then been multiplied by this ratio, as shown in Table A1-16. Since the total measured $PM_{2.5}$ concentration at the al Niepodleglosci site is known, the unknown variable is the contribution from other sources at this location. This has been calculated by subtracting the local road contribution from the total measurement, as shown in Table A1-16. The road-$PM_{2.5}$ concentration derived in this way is within the range that would be calculated by directly subtracting the ul. Wolkana measurement from each of the al. Niepodleglosci, Chroscickiego and Bajkowa measurements and is considered suitable for this study.

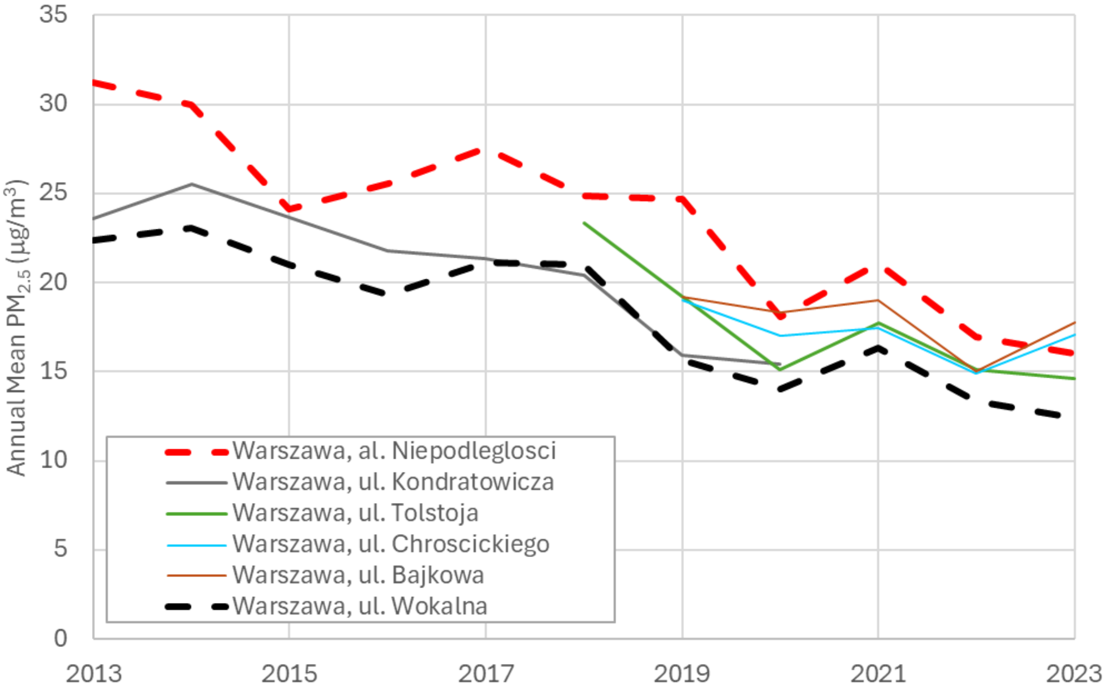


Figure A1-13: Annual Mean $PM_{2.5}$ Concentrations at Fixed Monitoring Sites in Warsaw, 2013 to 2023

Table A1-16: Apportioning the Measured $PM_{2.5}$ Concentration in Warsaw

Description	Value
Annual Mean NOx from Local Roads (µg/m³)	78.8
$PM_{2.5}$ to NOx ratio in Existing Baseline Traffic Emissions	0.0579
Annual Mean $PM_{2.5}$ from Local Roads (µg/m³)	4.6
Total Measured $PM_{2.5}$ (µg/m³)	16.0
Assumed Contribution from Other Sources (µg/m³)	11.4

A1.19 The surface level $PM_{2.5}$ concentrations predicted in the EMEP modelling using 2015 meteorological data for the grid cell in which the al. Niepodleglosci monitor lies are shown in Table A1-17. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the EMEP model predictions suggest that background $PM_{2.5}$ concentrations at the al. Niepodleglosci monitor will fall by 39% between 2023 and 2030 and by a further 14% between 2030 and 2040. Applying these percentage reductions to the 'contribution from other sources' value in Table A1-16 gives the year-specific background concentrations in Table A1-18. The values in Table A1-18 have been used in this study.

Table A1-17: Modelled Background $PM_{2.5}$ based on 2015 Meteorology for the Area Around the al. Niepodleglosci Site in Warsaw (µg/m³)[13]

2015	2030	2050
13.8	5.8	4.2

Table A1-18: Predicted Background $PM_{2.5}$ Concentrations at the al. Niepodleglosci Site in Warsaw (µg/m³)

2023	2030	2040
11.4	7.0	6.0

'Typical' Cities

NO_2 in 'Typical' Cities

A1.20 Figure A1-14 shows the monitoring sites used to define NO_2 concentrations in 'typical' Western European cities. Figure A1-15 show the same thing for Eastern Europe. The red dots show the roadside monitors, and the blue dots show the background monitors. Each roadside site has been paired with a nearby background monitor. Where no suitable background monitor was available, roadside sites have been excluded from the study and are not shown in Figure A1-14 and Figure A1-15. Similarly, where no suitable roadside monitor was available, background sites have been excluded and are not shown. In most cases the ‘paired’ background monitor is quite close to the roadside site. In some cases, they are further away but still considered broadly representative of local background air quality.

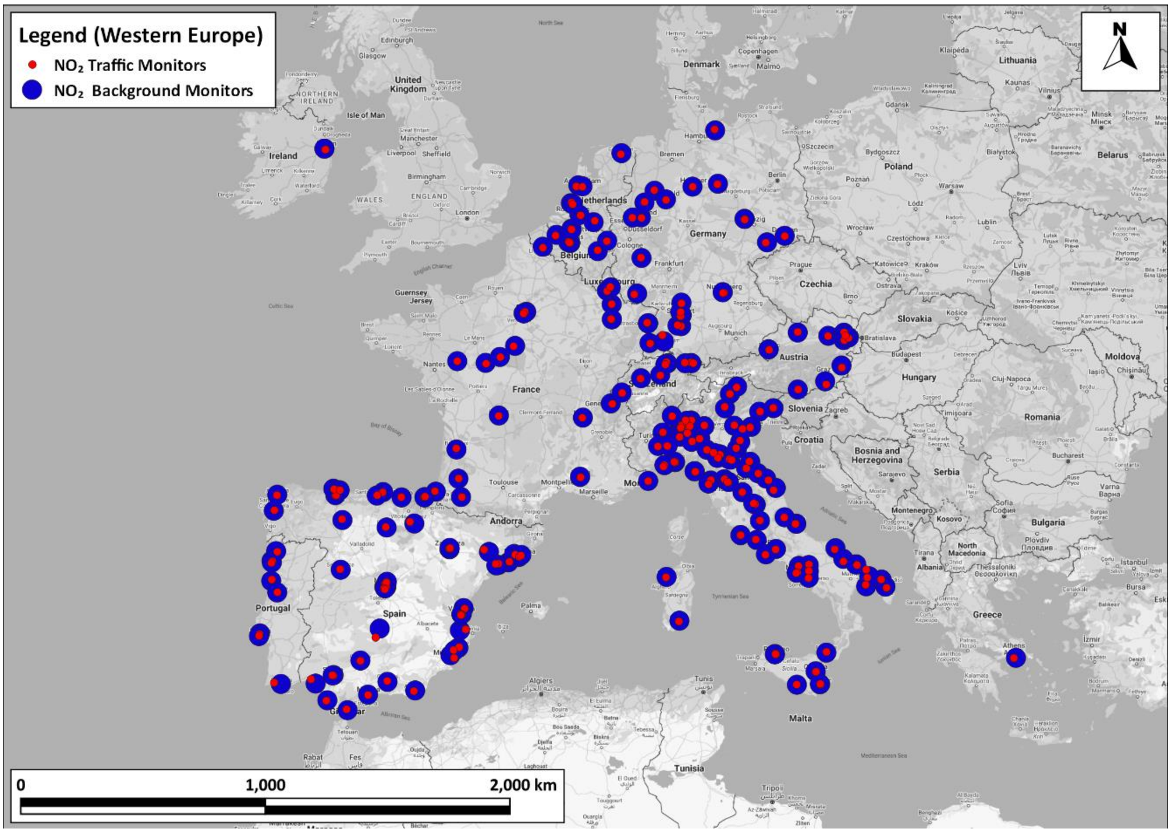


Figure A1-14: Roadside and Background NO_2 Monitoring Sites in Western Europe used in this Study

Map data ©2024 Google.

A1.21 Figure A1-16 summarises the annual mean concentrations measured during 2023 at each of the monitoring sites shown in Figure A1-14 and Figure A1-15. NO_2 concentrations at monitors which are classified (for reporting to the EEA) as roadside ranged from 3.8 $\mu g/m^3$ to 55.4 $\mu g/m^3$ in Western Europe and from 12.6 $\mu g/m^3$ to 49.4 $\mu g/m^3$ in Eastern Europe. NO_2 concentrations at monitors classified as background ranged from 3.5 $\mu g/m^3$ to 36.5 $\mu g/m^3$ in Western Europe and from 2.1 $\mu g/m^3$ to 29.1 $\mu g/m^3$ in Eastern Europe.

A1.22 It is likely that some of the roadside monitors included in Figure A1-16 are not close to busy roads and some might be significantly affected by other local emissions sources. Similarly, some of the background sites might not be ideally sited to represent local background conditions. For Paris, Milan and Warsaw the monitoring sites and their surroundings were reviewed in some detail, but this was not practical for all of the sites shown in Figure A1-14 and Figure A1-15. As a simple screening for inappropriately paired sites, pairs where the calculated local road contribution to NO_2 in 2023 (derived by subtracting the paired background measurement from each roadside measurement) was less than 5 $\mu g/m^3$ were removed. Experience suggests that a monitor within 5 m of a major road would currently experience traffic-related concentrations higher than 5 $\mu g/m^3$. Following this screening, there were 49 paired roadside monitors in Eastern Europe and 181 paired roadside monitors in Western Europe. NO_2 from local roads at these sites ranged from 5.2 $\mu g/m^3$ to 41.8 $\mu g/m^3$ in Western Europe and from 5.2 $\mu g/m^3$ to 40.5 $\mu g/m^3$ in Eastern Europe. The large numbers of sites included negates the uncertainty introduced by not examining each monitor setting in detail.

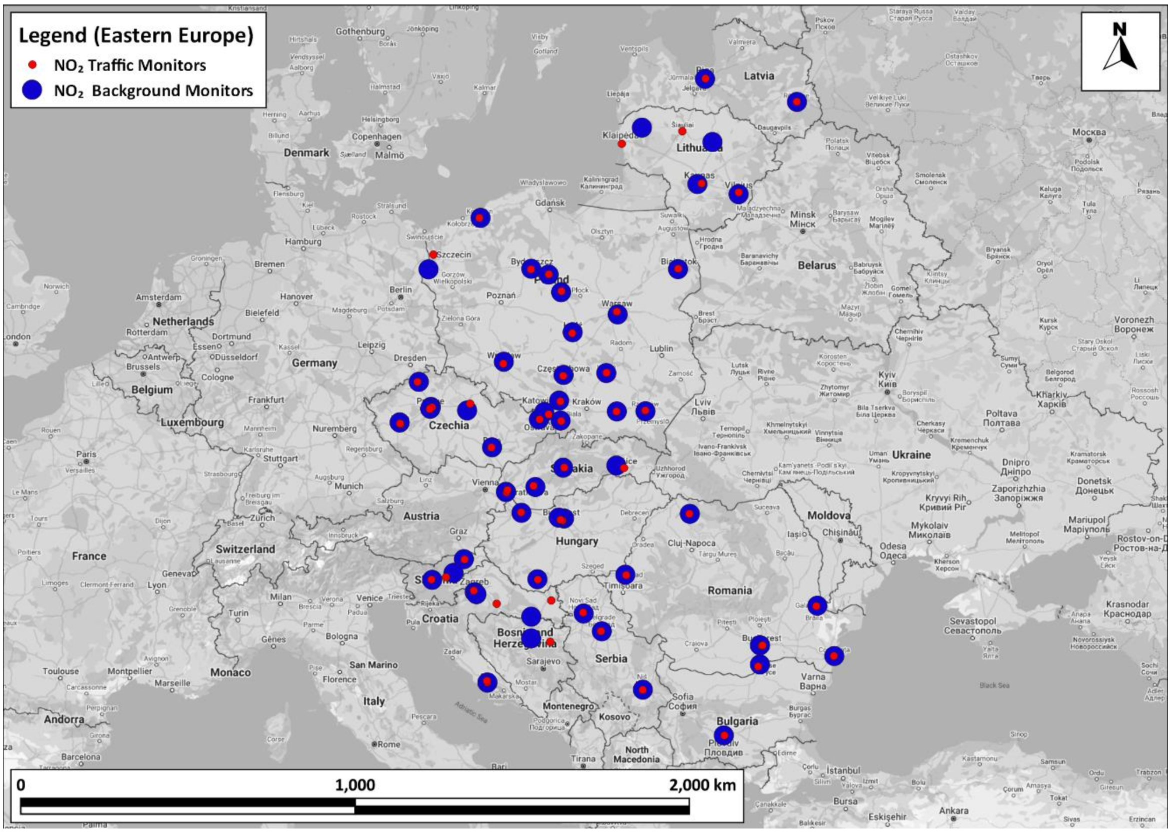


Figure A1-15: Roadside and Background NO_2 Monitoring Sites in Eastern Europe used in this Study

Map data ©2024 Google.

A1.23 The intention of the 'typical' city data is to present a reasonable worst-case of the roadside measurements reported to the EEA. It would be inappropriate to focus on the maximum values from Figure A1-16, since they do not represent many reported locations. The approach has been to take the 75th centile of all calculated NO_2 concentrations from local roads (i.e. the tops of the boxes in the lower panel of Figure A1-16) to represent local traffic-related NO_2 which might be experienced in a typical city. These values have been combined with the mean measured background concentrations which represent the average background across all of the data. Combining the 75th centile of local traffic-related NO_2 with the average background provides a reasonable worst-case.

A1.24 The EMEP modelling referred to in this study[13] predicts concentrations on a grid which is approximately 10 km x 10 km. The surface level NO_2 concentrations using 2015 meteorological data for the grid cells in which each of the background monitoring sites in Figure A1-14 and Figure A1-15 lie were determined from the Norwegian Meteorological Institute's data portal[13]. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the percentage reductions from the EMEP model predictions were applied to the 2023 measured background concentrations at each site. In this way, the NO_2 concentrations at each background monitor in 2030 and 2040 were predicted. These predictions are shown in Figure A1-17. The mean values for each year were used to represent 'typical' cities. There is significant variation across Europe in the rate of predicted change to background concentrations and so some cities are likely to see non-traffic NO_2 concentrations fall much more rapidly than others.

A1.25 Table A1-19 sets out the values derived from this analysis of Europe-wide monitoring and EMEP model data which are used in the main analysis to represent 'typical' cities.

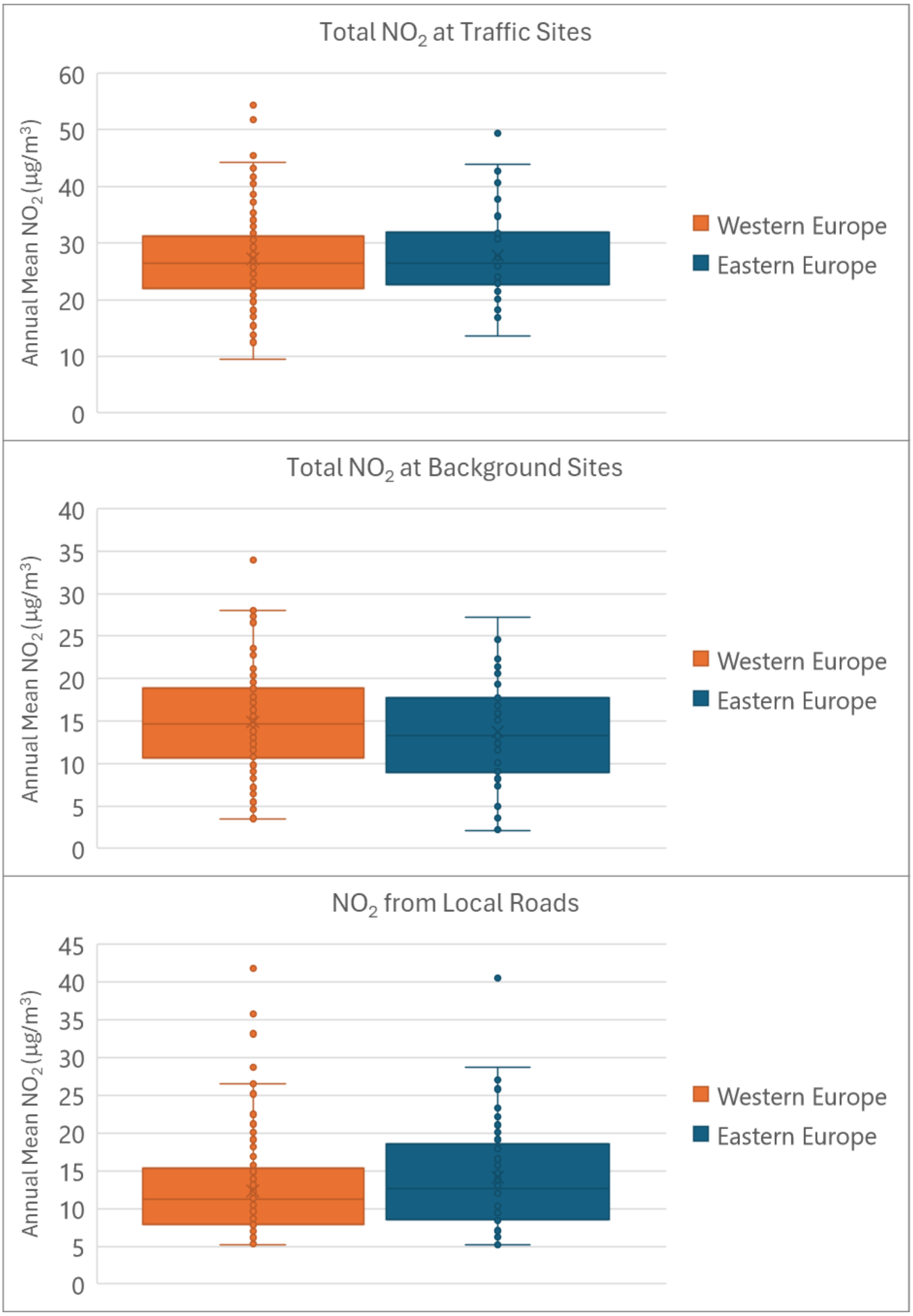


Figure A1-16: Summary of Annual Mean NO_2 Concentrations Measured During 2023 at Roadside and Background Monitoring Sites in Western and Eastern Europe, and the Road Increment Derived by Subtracting the Most Local Measured Background from each Roadside Value[26]

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[26] Each dot represents an individual value. The box shows the upper and lower quartiles, and the whiskers show the maxima and minima excluding outliers.

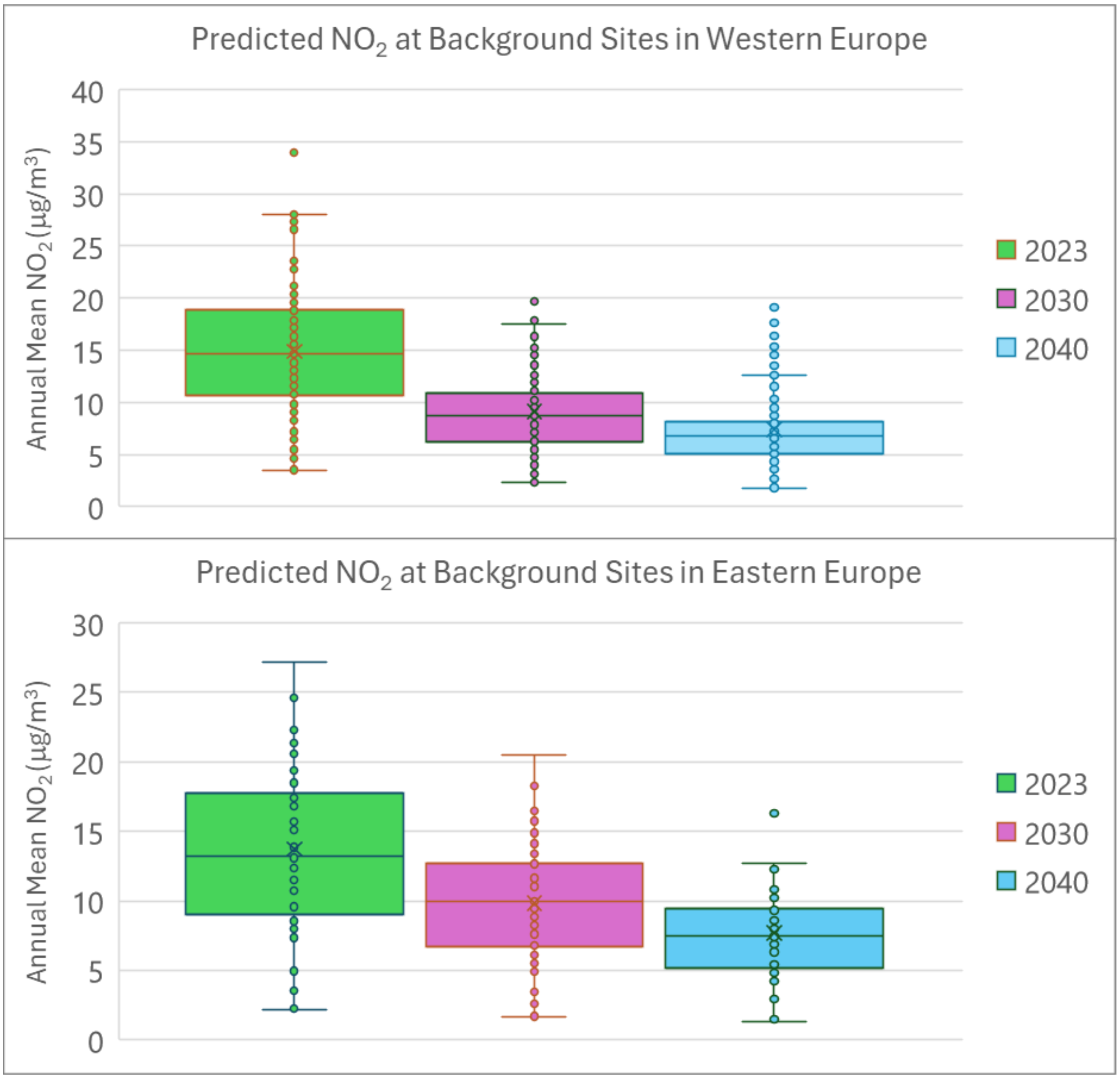

Figure A1-17: Current and Future Forecast Background NO_2 Concentrations at Relevant Monitoring Sites across Europe

Table A1-19: Monitoring-derived NO_2 Concentrations for the 'Typical' Cities

Description	Calculation	Region	Value ($\mu g/m^3$)
Local Road Increment to NO_2 Concentrations in 2023	75th centile of all (roadside total minus local background) measurements	Western Europe	15.4
		Eastern Europe	18.5
NO_2 from other sources in 2023	Mean of all background measurements	Western Europe	14.9
		Eastern Europe	13.7
NO_2 from other sources in 2030	Mean of all background measurements factored forward using local EMEP ratios	Western Europe	9.1
		Eastern Europe	9.8
NO_2 from other sources in 2040	Mean of all background measurements factored forward using local EMEP ratios	Western Europe	7.4
		Eastern Europe	7.7

$PM_{2.5}$ in 'Typical' Cities

A1.26 Figure A1-18 shows the monitoring sites which have been used to define $PM_{2.5}$ concentrations in 'typical' Western European cities. Figure A1-19 show the same thing for Eastern Europe. The red dots show the roadside monitors, and the blue dots show the background monitors. Each roadside site has been paired with a nearby background monitor. Where no suitable background monitor was available, roadside sites have been excluded from the study and are not shown in Figure A1-18 and Figure A1-19. Similarly, where no suitable roadside monitor was available, background sites have been excluded from the study and are not shown. In most cases the 'paired' background monitor is quite close to the roadside site. In some cases, they are further away but still considered broadly representative of local background air quality conditions.

A1.27 Figure A1-20 summarises the annual mean concentrations measured during 2023 at each monitoring site shown in Figure A1-18 and Figure A1-19. $PM_{2.5}$ concentrations at monitors classified (for reporting to the EEA) as roadside ranged from 4.6 $\mu g/m^3$ to 25.8 $\mu g/m^3$ in Western Europe and from 7.4 $\mu g/m^3$ to 31.2 $\mu g/m^3$ in Eastern Europe. $PM_{2.5}$ concentrations at monitors classified as background ranged from 4.5 $\mu g/m^3$ to 22.9 $\mu g/m^3$ in Western Europe and from 6.1 $\mu g/m^3$ to 27.0 $\mu g/m^3$ in Eastern Europe.

A1.28 As for NO_2, it is likely that some of the $PM_{2.5}$ monitors classified (for reporting to the EEA) are not close to busy roads and some might be significantly affected by other local emissions sources. Similarly, some of the background sites might not be ideally sited to represent local background conditions. As explained for NO_2, the surroundings of the monitoring sites in Paris, Milan and Warsaw were reviewed in some detail, but this was not practical for all of the sites shown in Figure A1-18 and Figure A1-19. As a simple screening for inappropriately paired sites, pairs where the calculated local road contribution to $PM_{2.5}$ in 2023 (derived by subtracting the paired background measurement from each roadside measurement) was less than 0.5 $\mu g/m^3$ were removed. Following this screening, there were 22 paired roadside monitors in Eastern Europe and 59 paired roadside monitors in Western Europe. $PM_{2.5}$ from local roads at these sites ranged from 0.5 $\mu g/m^3$ to 7.5 $\mu g/m^3$ in Western Europe and from 0.5 $\mu g/m^3$ to 11.8 $\mu g/m^3$ in Eastern Europe. The relatively large numbers of sites included negates the uncertainty introduced by not examining each monitor setting in detail.

A1.29 The intention of the 'typical' city data is to present a reasonable worst-case of roadside measurements which are reported to the EEA. It would not be appropriate to focus on the maximum values from Figure A1-20, since they do not represent many locations. As with NO_2, the approach has been to take the 75th centile of all calculated $PM_{2.5}$ concentrations from local roads (i.e. the tops of the boxes in the lower panel of Figure A1-20) to represent local traffic-related $PM_{2.5}$ concentrations which might be experienced in a typical city. These values have been combined with the mean measured background concentration. Combining the 75th centile of local traffic-related $PM_{2.5}$ with the average background provides a reasonable worst-case.

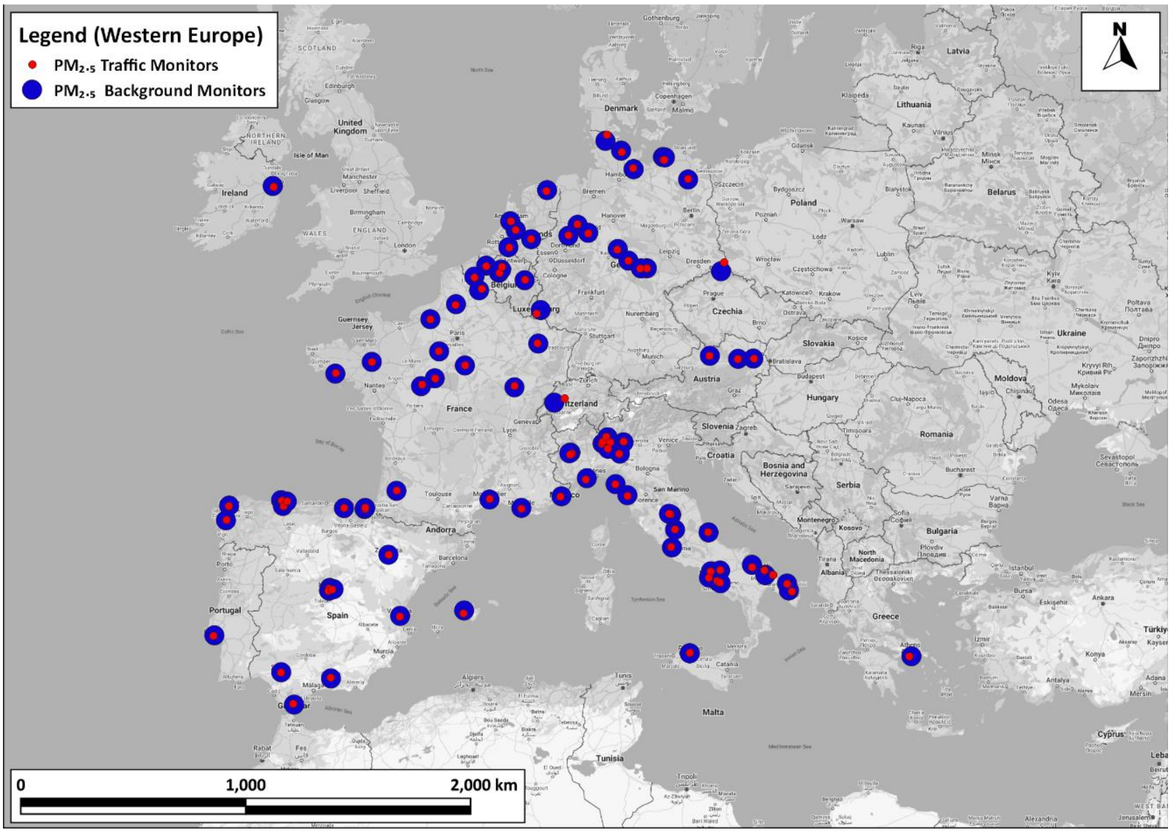

Figure A1-18: Roadside and Background $PM_{2.5}$ Monitoring Sites in Western Europe used in this Study

Map data ©2024 Google.

A1.30 The EMEP modelling referred to in this study[13] predicts concentrations on a grid which is approximately 10 km x 10 km. The surface level $PM_{2.5}$ concentrations using 2015 meteorological data for the grid cells in which each of the background monitoring sites in Figure A1-18 and Figure A1-19 lie were determined from the Norwegian Meteorological Institute's data portal[13]. Assuming a linear trajectory between 2015 and 2030 and between 2030 and 2050, the percentage reductions from the EMEP model predictions were applied to the 2023 measured background concentrations at each site. In this way, the $PM_{2.5}$ concentrations at each background monitoring site in 2030 and 2040 were predicted. These predictions are shown in Figure A1-21. The mean values for each year were used to represent 'typical' cities. As for NO_2, there is significant variation across Europe in the rate of predicted change to background concentrations and so some cities are likely to see non-traffic $PM_{2.5}$ concentrations fall much more rapidly than others.

A1.31 Table A1-20 sets out the values derived from this analysis of monitoring and EMEP model data which are used in the main analysis to represent 'typical' cities.

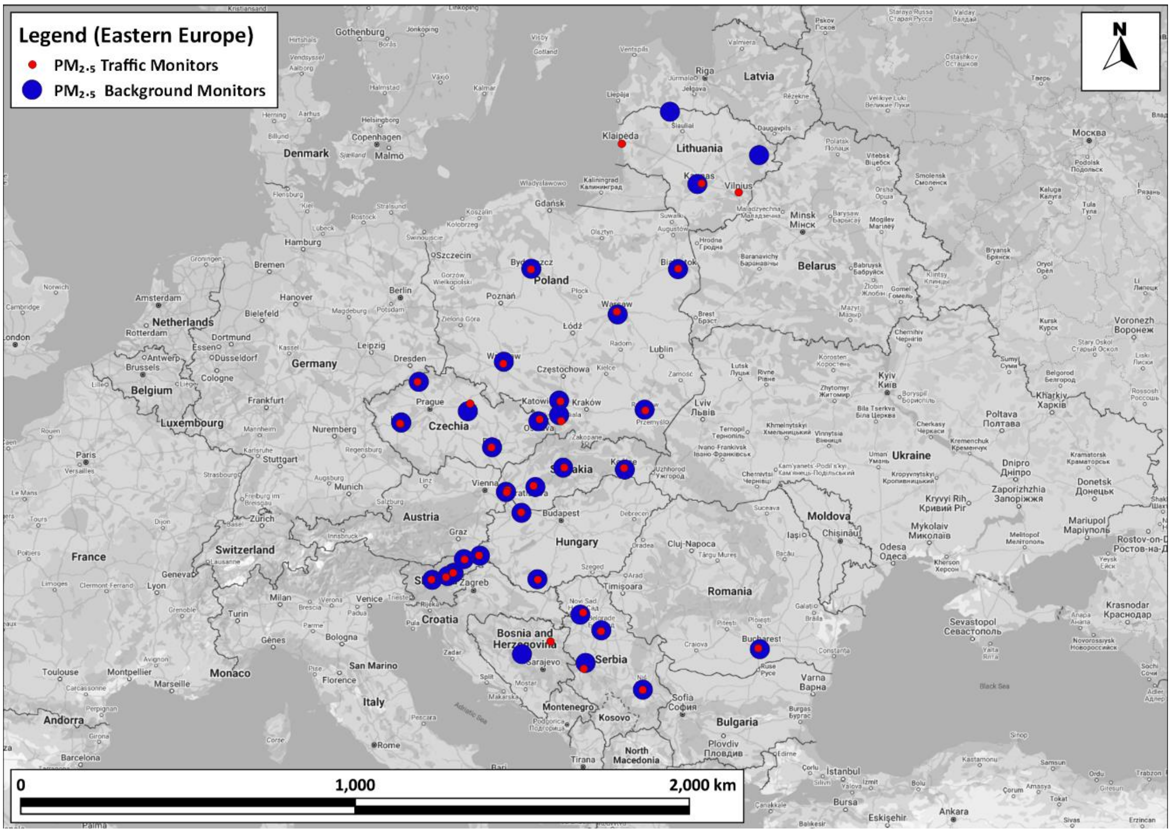

Figure A1-19: Roadside and Background $PM_{2.5}$ Monitoring Sites in Eastern Europe used in this Study

Map data ©2024 Google.

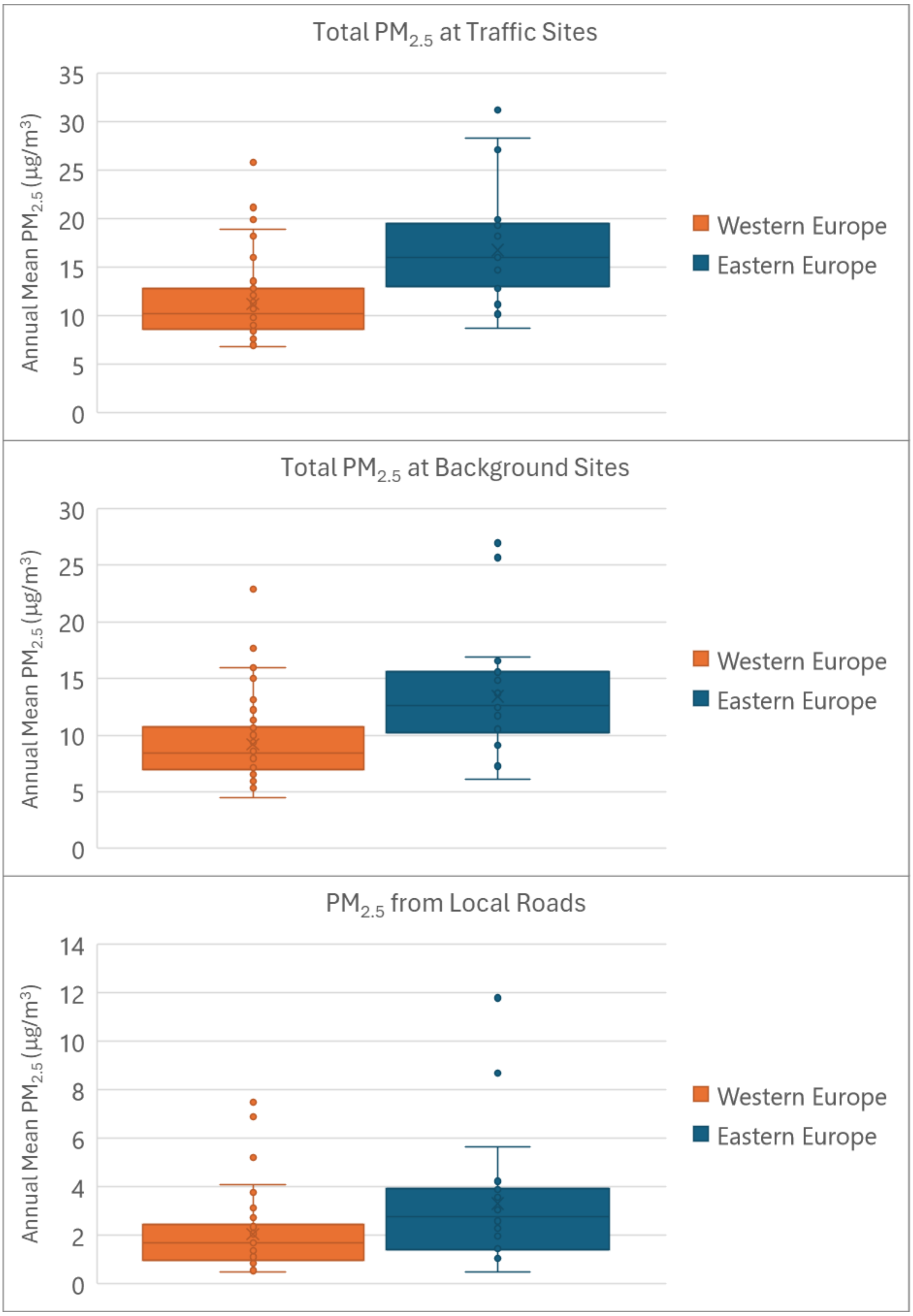

Figure A1-20: Summary of Annual Mean $PM_{2.5}$ Concentrations Measured During 2023 at Roadside and Background Monitoring Sites in Western and Eastern Europe, and the Road Increment Derived by Subtracting the Most Local Measured Background from each Roadside Value[26]

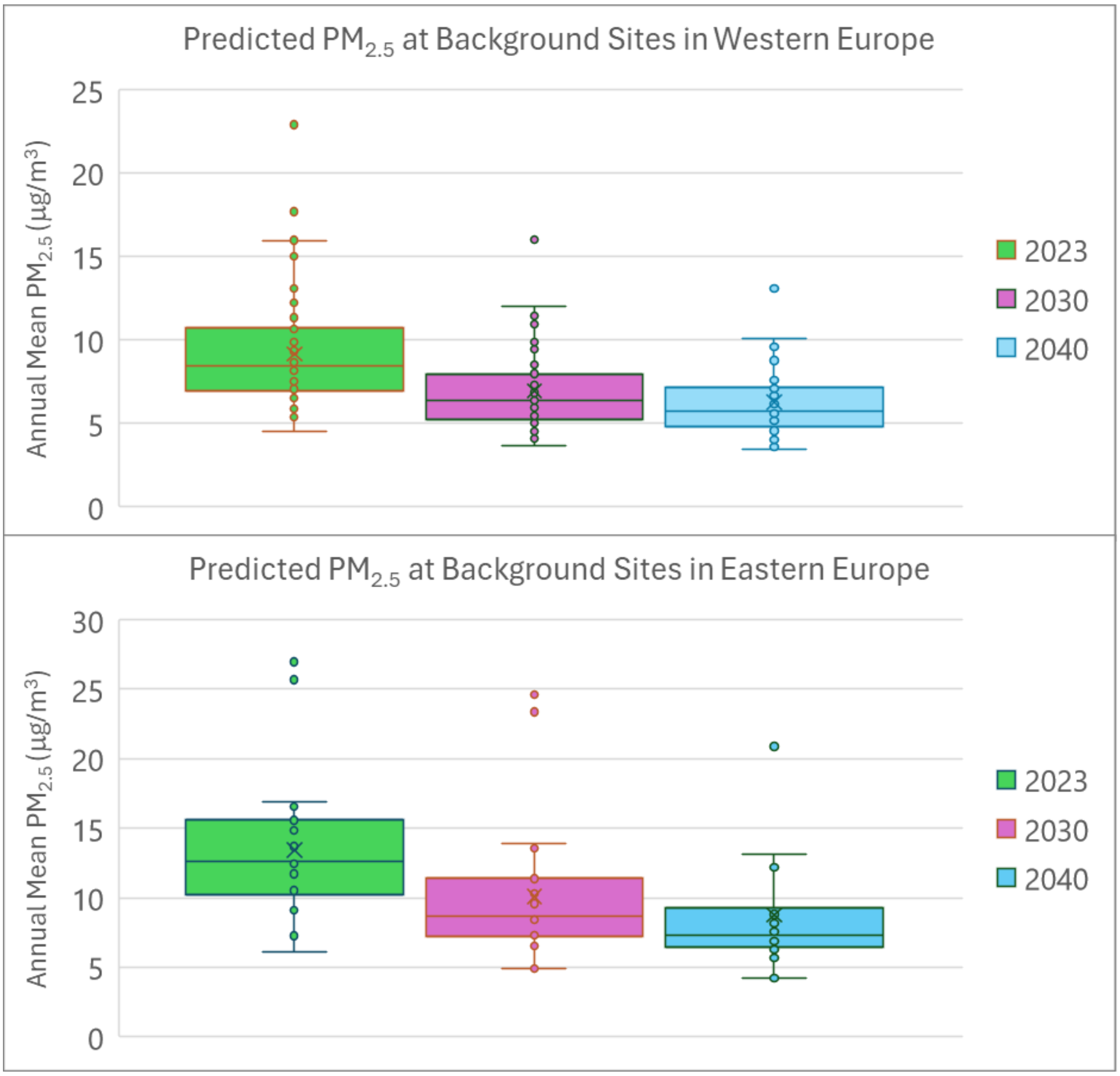

Figure A1-21: Current and Future Forecast Background PM$_{2.5}$ Concentrations at Relevant Monitoring Sites across Europe

Table A1-20: Monitoring-derived $PM_{2.5}$ Concentrations for the 'Typical' Cities

Description	Calculation	Region	Value ($\mu g/m^3$)
Local Road Increment to $PM_{2.5}$ Concentrations in 2023	75th centile of all (roadside total minus local background) measurements	Western Europe	2.5
		Eastern Europe	3.9
$PM_{2.5}$ from other sources in 2023	Mean of all background measurements	Western Europe	9.2
		Eastern Europe	13.5
$PM_{2.5}$ from other sources in 2030	Mean of all background measurements factored forward using local EMEP ratios	Western Europe	7.0
		Eastern Europe	10.1
$PM_{2.5}$ from other sources in 2040	Mean of all background measurements factored forward using local EMEP ratios	Western Europe	6.3
		Eastern Europe	8.8

A2 Baseline Fleet Assumptions

A2.1 The tables set out below summarise the vehicle fleet composition assumptions used for the 2023, 2030 and 2040 baseline scenarios. The values are expressed as a percentage of passenger cars (including zero exhaust emission vehicles 'ZEEVs'), percentage of light commercial vehicles (all termed 'vans' in this report but other light commercial vehicles are included), percentage of heavy duty trucks (termed HGVs in this report), percentage of L-category vehicles (i.e. motorcycles and other small motorised vehicles), and percentage of buses in 2023 (therefore, for example, where the sum of cars in 2040 in Warsaw exceeds 100, this indicates a growth in total car numbers between 2023 and 2040). These data have been mapped onto the full list of fleet descriptors in COPERT V5.7 assuming no change over time in the underlying basic fleet assumptions, as described in Section 2. For the intervention packages, these fleets have been adjusted according to the descriptions set out in the main report.

Baseline Fleets for Paris

Paris 2023 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	0.39	1.23	2.88	4.97	6.98	7.44	1.50	8.21
	Diesel	-	0.68	2.16	5.11	8.86	12.51	13.32	2.69	4.87
	Petrol Hybrid	-	-	-	-	2.81	2.08	2.21	0.45	2.44
	Diesel/biodiesel Hybrid	-	-	-	-	0.05	0.04	0.04	0.01	0.01
	PHEV running on petrol	-	-	-	-	0.06	0.04	0.05	0.01	0.76
	BEV	-	-	-	-	-	-	-	-	3.49
	PHEV running on electricity	-	-	-	-	0.06	0.04	0.05	0.01	0.76
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	0.00	0.01	0.03	0.05	0.07	0.41		
	CNG Bifuel	-				0.03	0.02	0.12		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.08	0.55	1.08	0.65	0.52	0.15	0.44
	Diesel	0.05	0.86	1.72	10.73	19.94	23.41	20.99	5.81	11.85
	ZEEV	1.17								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.02	-	-	-	-	-	-
	Diesel	0.01	0.11	2.09	8.75	8.78	26.07	54.01
	ZEEV	0.15						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.11	2.61	6.92	50.38	17.67	18.55
	Diesel	-	0.07	1.81	1.61	0.26	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	5.00	20.00	55.60	-
	ZEEV	19.40							

Paris 2030 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	0.00	1.03	2.08	3.26	4.01	0.89	14.90
	Diesel	-	-	0.00	2.27	4.69	7.49	9.19	2.06	8.52
	Petrol Hybrid	-	-	-	-	2.26	2.37	2.91	0.65	10.82
	Diesel/biodiesel Hybrid	-	-	-	-	0.02	0.02	0.03	0.01	0.03
	PHEV running on petrol	-	-	-	-	0.03	0.03	0.03	0.01	2.06
	BEV	-	-	-	-	-	-	-	-	15.11
	PHEV running on electricity	-	-	-	-	0.03	0.03	0.03	0.01	2.06
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	-	0.01	0.03	0.04	0.62		
	CNG Bifuel	-		--	-	0.01	0.01	0.37		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.00	0.05	0.38	0.75	0.45	0.36	0.11	1.13
	Diesel	0.04	0.60	1.20	7.49	13.92	16.35	14.66	4.06	30.43
	ZEEV	8.00								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.02	-	-	-	-	-	-
	Diesel	0.01	0.08	1.46	6.11	6.13	18.20	63.10
	ZEEV	4.89						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.07	1.82	4.84	35.19	12.34	43.12
	Diesel	-	0.05	1.27	1.12	0.18	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Paris 2040 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	-	-	-	0.57	0.89	0.22	6.66
	Diesel	-	-	-	-	-	2.00	3.10	0.77	5.15
	Petrol Hybrid	-	-	-	-	-	1.04	1.61	0.40	12.14
	Diesel/biodiesel Hybrid	-	-	-	-	-	0.01	0.01	0.00	0.02
	PHEV running on petrol	-	-	-	-	-	0.01	0.01	0.00	1.79
	BEV	-	-	-	-	-	-	-	-	61.27
	PHEV running on electricity	-	-	-	-	-	0.01	0.01	0.00	1.79
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	-	-	-	0.01	0.30		
	CNG Bifuel	-				-	0.00	0.19		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.00	0.03	0.23	0.45	0.27	0.22	0.06	1.12
	Diesel	0.02	0.36	0.72	4.49	8.34	9.79	8.78	2.43	30.25
	ZEEV	32.44								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.01	-	-	-	-	-	-
	Diesel	0.00	0.05	0.88	3.66	3.67	10.90	51.01
	ZEEV	29.82						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.04	1.09	2.90	21.07	7.39	65.94
	Diesel	-	0.03	0.76	0.67	0.11	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Baseline Fleets for Milan

Milan 2023 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	0.07	0.79	3.73	7.08	6.49	7.11	1.28	10.56
	Diesel	-	0.07	1.08	5.49	10.67	9.93	10.93	1.94	4.63
	Petrol Hybrid	-	-	-	-	2.78	1.55	1.69	0.31	2.51
	Diesel/biodiesel Hybrid	-	-	-	-	0.00	0.00	0.00	0.00	0.00
	PHEV running on petrol	-	-	-	-	0.04	0.02	0.02	0.00	0.36
	BEV	-	-	-	-	-	-	-	-	0.84
	PHEV running on electricity	-	-	-	-	0.04	0.02	0.02	0.00	0.36
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	0.01	0.12	0.62	1.21	1.12	2.00		
	CNG Bifuel	-				0.95	0.55	0.97		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.03	0.31	0.82	0.81	0.21	0.29	0.10	0.41
	Diesel	0.22	0.60	4.52	13.58	24.91	16.59	17.86	4.91	13.11
	ZEEV	0.73								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.01	-	-	-	-	-	-
	Diesel	0.27	1.74	8.67	23.90	16.06	15.14	34.06
	ZEEV	0.15						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	1.68	21.55	8.19	40.92	8.39	18.55
	Diesel	-	0.05	0.39	0.21	0.07	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	5.00	20.00	48.60	-
	ZEEV	26.40							

Milan 2030 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	0.00	0.52	2.57	3.56	4.70	0.96	19.30
	Diesel	-	-	0.00	0.81	4.80	7.21	9.66	1.91	10.92
	Petrol Hybrid	-	-	-	-	1.78	2.05	2.70	0.55	11.11
	Diesel/biodiesel Hybrid	-	-	-	-	0.00	0.00	0.00	0.00	0.00
	PHEV running on petrol	-	-	-	-	0.01	0.01	0.02	0.00	1.01
	BEV	-	-	-	-	-	-	-	-	6.41
	PHEV running on electricity	-	-	-	-	0.01	0.01	0.02	0.00	1.01
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	0.00	0.10	0.60	0.91	2.71		
	CNG Bifuel	-				0.31	0.40	1.36		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.02	0.22	0.57	0.57	0.14	0.20	0.07	1.08
	Diesel	0.16	0.42	3.15	9.48	17.40	11.58	12.47	3.43	34.04
	ZEEV	5.00								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.01	-	-	-	-	-	-
	Diesel	0.19	1.21	6.05	16.69	11.22	10.57	49.16
	ZEEV	4.89						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	1.18	15.05	5.72	28.58	5.86	43.12
	Diesel	-	0.04	0.27	0.15	0.05	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Milan 2040 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	-	-	-	0.18	0.98	0.31	12.66
	Diesel	-	-	-	-	-	0.53	2.90	0.90	9.51
	Petrol Hybrid	-	-	-	-	-	0.23	1.26	0.40	16.20
	Diesel/biodiesel Hybrid	-	-	-	-	-	0.00	0.01	0.00	0.03
	PHEV running on petrol	-	-	-	-	-	0.00	0.00	0.00	1.07
	BEV	-	-	-	-	-	-	-	-	49.45
	PHEV running on electricity	-	-	-	-	-	0.00	0.00	0.00	1.07
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	-	-	-	0.06	1.46		
	CNG Bifuel	-				-	0.02	0.75		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.13	0.34	0.34	0.09	0.12	0.04	0.78
	Diesel	0.09	0.25	1.89	5.68	10.42	6.94	7.47	2.05	24.79
	ZEEV	38.58								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.01	-	-	-	-	-	-
	Diesel	0.11	0.73	3.62	10.00	6.72	6.33	42.67
	ZEEV	29.82						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.70	9.01	3.43	17.11	3.51	65.94
	Diesel	-	0.02	0.16	0.09	0.03	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Baseline Fleets for Warsaw

Warsaw 2023 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	6.70	14.34	14.58	9.74	8.04	7.86	1.36	4.75
	Diesel	-	1.47	3.15	3.23	2.21	1.83	1.78	0.31	2.80
	Petrol Hybrid	-	-	-	-	9.81	1.74	1.70	0.29	1.03
	Diesel/biodiesel Hybrid	-	-	-	-	0.01	0.00	0.00	0.00	0.00
	PHEV running on petrol	-	-	-	-	0.00	0.00	0.00	0.00	0.04
	BEV	-	-	-	-	-	-	-	-	0.13
	PHEV running on electricity	-	-	-	-	0.00	0.00	0.00	0.00	0.04
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	0.08	0.17	0.17	0.12	0.10	0.36		
	CNG Bifuel	-				0.00	0.00	0.04		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.02	0.16	0.71	0.49	0.53	0.13	0.27
	Diesel	0.03	0.24	0.56	4.48	20.20	24.54	30.13	6.04	11.15
	ZEEV	0.29								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.07	-	-	-	-	-	-
	Diesel	0.16	0.49	3.36	12.44	14.70	20.09	48.53
	ZEEV	0.15						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	2.05	13.32	12.28	42.25	10.34	18.55
	Diesel	-	0.04	0.55	0.50	0.12	-
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	5.00	20.00	55.60	-
	ZEEV	19.40							

Warsaw 2030 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	0.00	16.82	11.18	8.69	9.16	1.71	14.15
	Diesel	-	-	0.00	5.55	3.80	2.97	3.11	0.58	9.03
	Petrol Hybrid	-	-	-	-	12.81	3.98	4.19	0.78	6.48
	Diesel/biodiesel Hybrid	-	-	-	-	0.01	0.00	0.00	0.00	0.01
	PHEV running on petrol	-	-	-	-	0.00	0.00	0.00	0.00	0.13
	BEV	-	-	-	-	-	-	-	-	1.29
	PHEV running on electricity	-	-	-	-	0.00	0.00	0.00	0.00	0.13
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	0.00	0.25	0.17	0.13	0.89		
	CNG Bifuel	-				0.00	0.00	0.11		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.02	0.11	0.50	0.34	0.37	0.09	0.87
	Diesel	0.02	0.17	0.39	3.13	14.10	17.13	21.04	4.22	35.48
	ZEEV	2.00								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.05	-	-	-	-	-	-
	Diesel	0.11	0.34	2.35	8.69	10.27	14.03	59.27
	ZEEV	4.89						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	1.43	9.30	8.57	29.51	7.22	43.12
	Diesel	-	0.03	0.39	0.35	0.09	-
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Warsaw 2040 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	-	-	-	16.27	15.94	2.88	30.98
	Diesel	-	-	-	-	-	7.29	7.07	1.27	22.75
	Petrol Hybrid	-	-	-	-	-	9.61	9.42	1.70	18.30
	Diesel/biodiesel Hybrid	-	-	-	-	-	0.02	0.02	0.00	0.07
	PHEV running on petrol	-	-	-	-	-	0.00	0.00	0.00	0.52
	BEV	-	-	-	-	-	-	-	-	11.36
	PHEV running on electricity	-	-	-	-	-	0.00	0.00	0.00	0.52
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	-	-	-	0.42	2.81		
	CNG Bifuel	-				-	0.00	0.40		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.00	0.01	0.07	0.30	0.21	0.22	0.05	1.19
	Diesel	0.01	0.10	0.23	1.87	8.44	10.26	12.60	2.53	48.84
	ZEEV	13.05								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.03	-	-	-	-	-	-
	Diesel	0.07	0.21	1.41	5.20	6.15	8.40	48.72
	ZEEV	29.82						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.86	5.57	5.13	17.67	4.32	65.94
	Diesel	-	0.02	0.23	0.21	0.05	-
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Baseline Fleets for a 'Typical' Western European City

'Typical' Western European City 2023 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	0.23	1.01	3.31	6.03	6.74	7.28	1.39	9.38
	Diesel	-	0.38	1.62	5.30	9.76	11.22	12.12	2.32	4.75
	Petrol Hybrid	-	-	-	-	2.80	1.81	1.95	0.38	2.48
	Diesel/biodiesel Hybrid	-	-	-	-	0.03	0.02	0.02	0.00	0.01
	PHEV running on petrol	-	-	-	-	0.05	0.03	0.03	0.01	0.56
	BEV	-	-	-	-	-	-	-	-	2.17
	PHEV running on electricity	-	-	-	-	0.05	0.03	0.03	0.01	0.56
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	0.01	0.07	0.32	0.63	0.60	1.21		
	CNG Bifuel	-	-	-	-	0.49	0.29	0.54		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.02	0.20	0.69	0.94	0.43	0.40	0.13	0.43
	Diesel	0.14	0.73	3.12	12.15	22.43	20.00	19.43	5.36	12.48
	ZEEV	0.95								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.02	-	-	-	-	-	-
	Diesel	0.14	0.92	5.38	16.33	12.42	20.60	44.03
	ZEEV	0.15						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.90	12.08	7.56	45.65	13.03	18.55
	Diesel	-	0.06	1.10	0.91	0.17	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	5.00	20.00	52.10	-
	ZEEV	22.90							

'Typical' Western European City 2030 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	0.00	0.77	2.32	3.41	4.35	0.92	17.10
	Diesel	-	-	0.00	1.54	4.74	7.35	9.42	1.98	9.72
	Petrol Hybrid	-	-	-	-	2.02	2.21	2.81	0.60	10.96
	Diesel/biodiesel Hybrid	-	-	-	-	0.01	0.01	0.01	0.00	0.01
	PHEV running on petrol	-	-	-	-	0.02	0.02	0.03	0.01	1.54
	BEV	-	-	-	-	-	-	-	-	10.76
	PHEV running on electricity	-	-	-	-	0.02	0.02	0.03	0.01	1.54
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	0.00	0.05	0.31	0.47	1.66		
	CNG Bifuel	-	-	-	-	0.16	0.21	0.87		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.14	0.48	0.66	0.30	0.28	0.09	1.10
	Diesel	0.10	0.51	2.18	8.49	15.66	13.97	13.57	3.75	32.24
	ZEEV	6.50								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.01	-	-	-	-	-	-
	Diesel	0.10	0.64	3.76	11.40	8.68	14.39	56.13
	ZEEV	4.89						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.63	8.43	5.28	31.88	9.10	43.12
	Diesel	-	0.04	0.77	0.63	0.12	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

'Typical' Western European City 2040 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	-	-	-	0.38	0.93	0.27	9.66
	Diesel	-	-	-	-	-	1.26	3.00	0.84	7.33
	Petrol Hybrid	-	-	-	-	-	0.64	1.44	0.40	14.17
	Diesel/biodiesel Hybrid	-	-	-	-	-	0.00	0.01	0.00	0.02
	PHEV running on petrol	-	-	-	-	-	0.00	0.01	0.00	1.43
	BEV	-	-	-	-	-	-	-	-	55.36
	PHEV running on electricity	-	-	-	-	-	0.00	0.01	0.00	1.43
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	-	-	-	0.04	0.88		
	CNG Bifuel	-	-	-	-	-	0.01	0.47		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.08	0.29	0.39	0.18	0.17	0.05	0.95
	Diesel	0.06	0.30	1.30	5.08	9.38	8.36	8.12	2.24	27.52
	ZEEV	35.51								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.01	-	-	-	-	-	-
	Diesel	0.06	0.39	2.25	6.83	5.19	8.61	46.84
	ZEEV	29.82						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.37	5.05	3.16	19.09	5.45	65.94
	Diesel	-	0.03	0.46	0.38	0.07	0.00
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Baseline Fleets for a 'Typical' Eastern European City

Typical' Eastern European City 2023 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	6.70	14.34	14.58	9.74	8.04	7.86	1.36	4.75
	Diesel	-	1.47	3.15	3.23	2.21	1.83	1.78	0.31	2.80
	Petrol Hybrid	-	-	-	-	9.81	1.74	1.70	0.29	1.03
	Diesel/biodiesel Hybrid	-	-	-	-	0.01	0.00	0.00	0.00	0.00
	PHEV running on petrol	-	-	-	-	0.00	0.00	0.00	0.00	0.04
	BEV	-	-	-	-	-	-	-	-	0.13
	PHEV running on electricity	-	-	-	-	0.00	0.00	0.00	0.00	0.04
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	0.08	0.17	0.17	0.12	0.10	0.36		
	CNG Bifuel	-				0.00	0.00	0.04		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.02	0.16	0.71	0.49	0.53	0.13	0.27
	Diesel	0.03	0.24	0.56	4.48	20.20	24.54	30.13	6.04	11.15
	ZEEV	0.29								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.07	-	-	-	-	-	-
	Diesel	0.16	0.49	3.36	12.44	14.70	20.09	48.53
	ZEEV	0.15						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	2.05	13.32	12.28	42.25	10.34	18.55
	Diesel	-	0.04	0.55	0.50	0.12	-
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	5.00	20.00	55.60	-
	ZEEV	19.40							

Typical' Eastern European City 2030 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	0.00	16.82	11.18	8.69	9.16	1.71	14.15
	Diesel	-	-	0.00	5.55	3.80	2.97	3.11	0.58	9.03
	Petrol Hybrid	-	-	-	-	12.81	3.98	4.19	0.78	6.48
	Diesel/biodiesel Hybrid	-	-	-	-	0.01	0.00	0.00	0.00	0.01
	PHEV running on petrol	-	-	-	-	0.00	0.00	0.00	0.00	0.13
	BEV	-	-	-	-	-	-	-	-	1.29
	PHEV running on electricity	-	-	-	-	0.00	0.00	0.00	0.00	0.13
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	0.00	0.25	0.17	0.13	0.89		
	CNG Bifuel	-				0.00	0.00	0.11		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.01	0.02	0.11	0.50	0.34	0.37	0.09	0.87
	Diesel	0.02	0.17	0.39	3.13	14.10	17.13	21.04	4.22	35.48
	ZEEV	2.00								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.05	-	-	-	-	-	-
	Diesel	0.11	0.34	2.35	8.69	10.27	14.03	59.27
	ZEEV	4.89						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	1.43	9.30	8.57	29.51	7.22	43.12
	Diesel	-	0.03	0.39	0.35	0.09	-
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

Typical' Eastern European City 2040 (per 100 cars, 100 vans, 100 HGVs, 100 L-category vehicles, and 100 buses in 2023)

Passenger Cars		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	-	-	-	-	-	16.27	15.94	2.88	30.98
	Diesel	-	-	-	-	-	7.29	7.07	1.27	22.75
	Petrol Hybrid	-	-	-	-	-	9.61	9.42	1.70	18.30
	Diesel/biodiesel Hybrid	-	-	-	-	-	0.02	0.02	0.00	0.07
	PHEV running on petrol	-	-	-	-	-	0.00	0.00	0.00	0.52
	BEV	-	-	-	-	-	-	-	-	11.36
	PHEV running on electricity	-	-	-	-	-	0.00	0.00	0.00	0.52
	Fuel Cell	-	-	-	-	-	-	-	-	-
	LPG Bifuel	-	-	-	-	-	0.42	2.81		
	CNG Bifuel	-				-	0.00	0.40		
	Bioethanol	-	-	-	-	-	-	-	-	-

Vans		Older Misc	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6 a/b/c	Euro 6 d-temp	Euro 6 d
	Petrol	0.00	0.00	0.01	0.07	0.30	0.21	0.22	0.05	1.19
	Diesel	0.01	0.10	0.23	1.87	8.44	10.26	12.60	2.53	48.84
	ZEEV	13.05								

HGVs		Conv	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
	Petrol	0.03	-	-	-	-	-	-
	Diesel	0.07	0.21	1.41	5.20	6.15	8.40	48.72
	ZEEV	29.82						

L-Category		Conv	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
	Petrol	0.86	5.57	5.13	17.67	4.32	65.94
	Diesel	-	0.02	0.23	0.21	0.05	-
	ZEEV	-					

Buses		EEV	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI	Conv
	Diesel	-	-	-	-	-	-	5.00	-
	ZEEV	95.00							

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