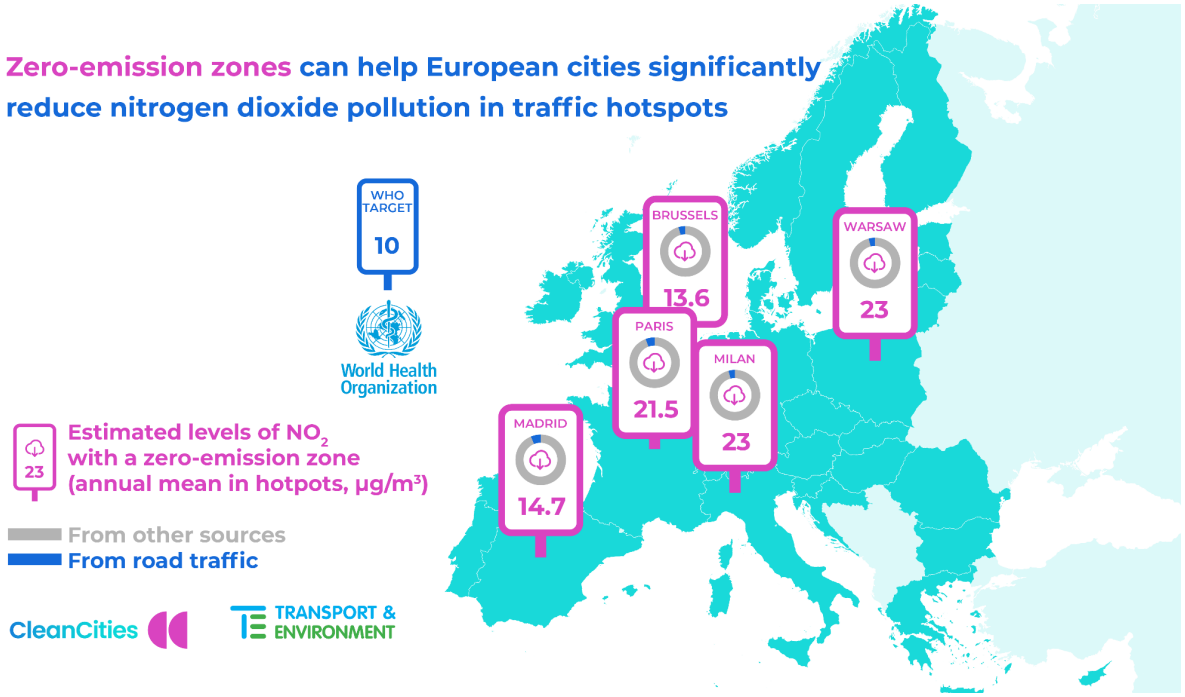
Factsheet

New evidence for EU clean air law (AAQD) revision: Air quality modelling shows significant air pollution cuts are possible thanks to low- and zero-emission zones

New research commissioned by the Clean Cities Campaign and Transport & Environment shows low- and zero-emission zones can significantly reduce air pollution levels. Even at the most polluted traffic hotspots in cities, the guidelines of the World Health Organisation (WHO) for nitrogen dioxide pollution are within reach if zero-emission zones are introduced by 2030. This is before considering additional reductions through other policies or from other sources. These findings should inform the ongoing revision of the EU's Ambient Air Quality Directive and prompt the EU to set science-based legal limits and accelerate the roll-out of zero-emission transport in Europe.



The main findings of the research are:

- **More stringent low-emission zones can curb NO_2 pollution from local roads by between 36% (Milan) to 45% (Madrid) at traffic hotpots by 2027. This brings total concentrations (roadside plus other sources) at most city hotpots down to as low as 25.8 µg/m³, much closer to the 20 µg/m³ target that the European Commission proposed only for 2030.**
- **In 2030, zero-emission zones can almost eliminate NO_2 emissions from local roads[1], leaving only the contribution from other sources. Reductions range from 91% (Milan) to 95% (Paris, Brussels). Total NO_2 levels of 13.6 µg/m³ (Brussels) to 23 µg/m³ (Milan and Warsaw) can be achieved.**

[1] It is assumed that there is a 95% compliance rate with the ZEZ - i.e. 5% of vehicles will remain as internal combustion engine (ICE) vehicles in 2030, for example via exemptions for people with special needs cars. In addition, L-category vehicles, i.e. 2- and 3-wheel vehicles and quadricycles were not included in this analysis.

- **The modelling contains several worst-case assumptions, and in particular does not allow for any significant ambition in targeting the remaining non-transport emissions. This means that the future-year predictions are likely to be conservative and that lower concentrations than predicted here are highly achievable with additional and combined efforts to tackle other pollution sources.**

Introduction: the proposed revision of EU clean air laws ignores the impact of LEZs/ZEZs

Despite improvements over the past decade, air pollution remains the biggest environmental threat to human health. Nitrogen dioxide (NO_2) concentrations - of which road transport is the principal source - are responsible for 64,000 premature deaths in the EU every year[2]. The Ambient Air Quality Directive (AAQD) - with the current directive dating all the way back to 2008 - sets concentration limits for certain pollutants that are considered harmful, including NO_2 and fine $PM_{2.5}$ (particles less than 2.5 µm in diameter) and sets instructions for member states on how to reduce pollution if the standards are not complied with. The European Commission published its proposal for a revised AAQD in October 2022[3], which proposes aligning the EU's standards more closely with the recommendations of the WHO, but stopped short of full alignment.[4]

Compliance with EU limit values under the AAQD depends on how quickly pollution can be reduced across each member state and especially in the areas with the maximum reported concentrations of air pollution. Measures to improve air quality in these so-called air pollution hotspots usually combine international, national, and local actions. Local actions such as low-emission zones (LEZs) and zero-emission zones (ZEZs) can be particularly effective in cutting emissions quickly, a previous review of the available evidence showed.[5]

Despite this, the European Commission's impact assessment[6] that accompanied its proposals for a revised AAQD did not take into account the potential pollution abatement impacts of further LEZs and ZEZs, thereby missing a key policy tool which might help member states to achieve future, more ambitious, limit values. There are already 325 LEZs in place across Europe, and more than 500 LEZs and 35 ZEZs are set to be introduced by 2030[7]. This study aims to fill this gap and shows the additional benefits that can be expected from the implementation of stricter LEZs as well as ZEZs across five EU cities: Madrid, Paris, Brussels, Milan and Warsaw.[8]

[2] https://www.eea.europa.eu/en/topics/in-depth/air-pollution
[3] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6278
[4] The World Health Organization has set a target of 10 µg/m³ for NO_2, whereas the proposed EU annual limit value is set at 20 µg/m³ (twice as high). For $PM_{2.5}$, the WHO target is 5 µg/m³ and the proposed EU limit value 10 µg/m³ (twice as high).
[5] https://cleancitiescampaign.org/research-list/quantifying-the-impact-of-low-and-zero-emission-zones/
[6] https://environment.ec.europa.eu/publications/revision-eu-ambient-air-quality-legislation_en
[7] ttps://cleancitiescampaign.org/research-list/the-development-trends-of-low-and-zero-emission-zones-in-europe/
[8] London was also included in the modelling but, given its location outside of the EU and its existing, ambitious Ultra-Low Emission Zone (ULEZ), different scenarios were analysed and are not included here.

Methodology: modelling the impact of 3 scenarios in selected cities

Based on previous work commissioned by Transport & Environment[9], experts at *Air Quality Consultants Ltd.* developed a bespoke methodology that uses recent measured concentrations from fixed monitoring stations in the selected cities, combined with the predicted changes to transport emissions in order to estimate future ambient concentrations. While the methodology has been simplified in comparison to detailed spatial modelling, the outcomes are suitable to demonstrate the effects that LEZs and ZEZs might have on worst-case pollution concentrations within each city (see details in the technical report). The modelling contains several worst-case assumptions, and in particular does not account for any significant ambition in targeting non-transport emissions. This means that the future-year predictions are likely to be precautionary and that lower concentrations than predicted here are highly achievable with combined effort.

Main results

The results confirm that stricter low-emission zones can further reduce local air pollution and that zero-emission zones bring within reach the WHO air quality guidelines. Implementing stricter low-emission zones allowing only the most recent Euro 6d(-temp) petrol and diesel cars to circulate, without considering any additional measures, brings total concentrations of NO_2 (roadside plus other sources) in several city hotpots much closer to the 20 µg/m^3 target proposed by the European Commission already in 2027 (with compliance required in 2030 in the Commission proposal).

Table 1: Overview of the NO_2 effects of a stricter low-emission zone in 2027[10]

City	Madrid	Greater Paris	Brussels	Milan	Warsaw
Reduction in NO_2 levels from local roads over baseline	-45%	-40%	-37%	-36%	-39%
NO_2 from local roads in µg/m^3	9.6	15.6	9.8	13.1	11.1
Total NO_2 in µg/m^3	25.8	38.1	26.0	34.4	33.2

Using one of the cities modelled as an illustrative example, in Madrid, NO_2 concentrations from local roads are projected to fall by 14% and $PM_{2.5}$ by 17% by 2025 compared to the baseline for the same year (without a stricter low-emission zone), assuming a LEZ allowing only diesel vehicles of Euro 5 standard and petrol Euro 4 vehicles to circulate. Under a stricter LEZ allowing only Euro 6d(-temp) vehicles (the most recent Euro standard), roadside NO_2 is projected to fall by 45% in 2027 compared to the baseline scenario of the same year without a tightened LEZ, with a 21% drop for $PM_{2.5}$. Under this scenario, total NO_2 concentrations (including emissions from background sources)

[9] Transport & Environment. (2021). Blue Sky Recovery. How to keep lockdown low levels of air pollution in European cities. Link

[10] The 2027 scenario assumes that existing or planned LEZs are tightened to only allow Euro 6d(-temp) cars to circulate, that 95% of vehicles will comply with the rules and that motorised road traffic is reduced by 10% over 2019 levels through traffic avoidance and modal shift (as already observed in London's ULEZ).

are projected to fall to 25.8 µg/m^3 and total $PM_{2.5}$ to 10.2 µg/m^3 already by 2027 - almost in line with the European Commission's proposed limit values for 2030 (of 20 µg/m^3 for NO_2 and 10 µg/m^3 for $PM_{2.5}$). Finally, under the ZEZ scenario, roadside NO_2 concentrations are projected to fall by 94% compared to the 2030 baseline scenario without the zone, to just 0.9 µg/m^3, with total concentrations down to 14.7 µg/m^3, very close to the WHO guideline limit of 10 µg/m^3. Crucially, this is before considering the impact of additional pollution abatement measures in other sectors, therefore emissions from sources other than local roads is likely to have been over-predicted in 2030.

Importantly, the results also show that by 2030, even in the NO_2 hotspots in some of Europe's most polluted cities, it is possible to get close to meeting the WHO targets of 10 µg/m^3 if zero-emission zones are introduced. And this is before any additional action is taken in other NO_2-polluting sectors including energy generation, agriculture and buildings. Putting in place a zero-emission zone would enable easy compliance with the European Commission's proposal by 2030 for both NO_2 (20 µg/m^3 instead of 10 µg/m^3 as defined by the WHO) and $PM_{2.5}$ (10 µg/m^3 instead of 5 µg/m^3 as defined by the WHO) in most cities, assuming additional action is taken to reduce other background sources of pollution for e.g. industry, agriculture and energy. With roadside NO_2 emissions almost entirely eliminated in all cities, authorities would not have far to go in reducing emissions from other sources before they can meet the World Health Organisation's air quality guideline of 10 µg/m^3.

Table 2: Overview of the NO_2 effects of a zero-emission zone in 2030[11]

City	Madrid	Greater Paris	Brussels	Milan	Warsaw
Reduction in NO_2 levels from local roads over baseline	-94%	-95%	-95%	-91%	-94%
NO_2 from local roads in µg/m^3	0.9	1.2	0.6	1.7	0.9
Total NO_2 in µg/m^3	14.7	21.5	13.6	23.0	23.0

For particulate matter ($PM_{2.5}$), the story is slightly different as emissions from local roads make up a smaller contribution of total $PM_{2.5}$ concentrations than is the case for NO_2. Furthermore, zero-emission vehicles will continue to emit non-exhaust emissions from brake and tire wear, meaning the relative change of implementing a ZEZ is smaller. Nevertheless, the additional local benefits that could be delivered by both ambitious LEZs and ZEZs remain significant, with the results from the modelling showing that PM2.5 from local roads can be reduced by 44% to 48% in a zero-emission zone.

Under an ambitious LEZ, total concentrations of $PM_{2.5}$ in 2027 range from between 10.2 µg/m^3 in Madrid (already at the Commission's proposed target for 2030) and 20 µg/m^3 in Milan. Under a ZEZ, total concentrations of $PM_{2.5}$ range from as low as 9.2µg/m^3 in Madrid to 18.8 µg/m^3 in Milan. When

[11] The zero-emission scenario assumes that 95% of all four-wheel vehicles use zero-emission technology and that motorised road traffic is reduced by 20% over 2019 levels through traffic avoidance and modal shift.

combined with actions to reduce emissions from other sources, these policies could result in significant reductions at worst-case reporting locations in each city and put them on a feasible path to compliance with WHO guidelines. You can see the full detailed results in the report here.

Key recommendations (from T&E and CCC)

1	**Align the revised limit values of the AAQD with the most recent WHO guidelines by 2030 at the latest**. New evidence, outlined in this factsheet, shows that LEZs and ZEZs (left out from the Commission's Impact Assessment) can bring pollution down close to these limits, even in the worst hotspots and without considering the impact of additional abatement measures in transport and other sectors.
2	**Air quality standards should be based on binding concentration limit values**. Limit values are legally enforceable maximum levels of each individual air pollutant which must be respected by a given deadline. Average exposure reduction targets should only be a complementary tool bringing additional information on the share of European citizens exposed to illegal concentrations of air pollution.
3	**Require competent authorities drawing up Air Quality Plans to consider measures including LEZs and ZEZs** (listed in Annex VIII Part B of the proposed Directive) if emissions from transport are identified as contributing to exceedances of limit values for NO_2 and/or PM.
4	**Expand the list of recommended air pollution abatement measures in Annex VIII Part B to include best practice measures** such as zero-emission zones, congestion charges, and other Urban Vehicles Access Regulations (UVARs); low-traffic zones; reducing speed limits to 30km/h in cities; promoting active (walking, cycling) and shared/public transport (micromobility, car-sharing).
5	**Require authorities to provide explanations in case these measures are not included** in the final version of the plans (Article 19 & Annex VIII) **and provide evidence that the selected measures will achieve at least an equivalent reduction in concentrations**.

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