

Road to Zero: the last EU emission standard for cars, vans, buses and trucks

T&E blueprint for post-Euro 6/VI regulations

April 2020

Four years on from the Dieselgate scandal - which exposed the failure to curb toxic air pollution from cars and shook confidence in EU emissions regulation - Europe is in the process of setting a new pollutant emissions standard for light and heavy duty vehicles. The future 'post Euro-6/VI' (informally called 'Euro 7/VII') norm gives the European Union the opportunity to eradicate pollution from road transport, regain technological and regulatory leadership, and align standards with its new 'Zero Pollution Ambition' and the objective of net-zero greenhouse gas emissions by 2050. Europe is currently in the middle of a global health crisis triggered by the COVID-19 pandemic, and the health, safety and job security of workers are rightly a priority for lawmakers. This makes the objectives of post-Euro 6/VI more important than ever. Public health experts warn that polluted air probably makes people more susceptible to viruses¹ and the World Health Organisation has stated that climate change will likely increase the occurrence of infectious diseases.²

Although the latest Euro 6d-temp/6d standards have somewhat reduced emissions from new cars, progress has been limited. Vehicles with combustion engines - diesel, petrol or natural gas - are still not clean when all pollutants or driving conditions are taken into account. It is time to prioritise public health, the environment and zero emissions technology innovation. For the post-Euro 6/VI standard, the EU's priorities must be:

1. **Set the EU vehicle emission limits to the lowest level globally and define a clear roadmap to zero.** Official data from manufacturers and recent independent studies show that lower emission limits are already feasible. Some cars on sale today already emit less than a quarter of the current NOx limits^{3,4} and for heavy duty vehicles, research has shown

¹ European Public Health Alliance. (16th March 2020) [Coronavirus threat greater for polluted cities.](#)

² World Health Organisation. (30th March 2020) [Climate change and human health - risks and responses. Summary.](#)

³ 80mg/km for diesel cars and 60mg/km for petrol cars.

⁴ T&E. (2019) [EU must withdraw carmakers 'license to pollute' as data shows new cars meet limits. 2019.](#) based on data available in the ACEA and JAMA RDE databases in March 2019.

that NO_x emissions can be reduced to just 10% of the current limit (460 mg/kWh) using off the shelf technology⁵. At present the EU is set to fall behind stricter limits in China by 2023 and the U.S. by 2025. Therefore the EU must move rapidly to **set the lowest emission limits globally** based on best available technology, as soon as possible. These limits must be fuel-neutral and apply to **all internal combustion engines, including compressed/liquified natural gas (CNG/LNG), port-fuel injection petrol engines and advanced/synthetic fuels and hybrids**. Post-Euro 6/VI should be the last standard that allows any emissions and it should map out a clear pathway (in 5 year intervals) towards only zero emission new vehicle sales. This should involve the setting of strict emission limits for 2025 and stricter still ultra low emission limits for 2030. From 2035 onwards, only zero emission light-duty vehicles and heavy duty vehicles (below 26 tonnes) must be sold; by 2040 all new trucks must be zero emission.

- 2. Regulate all pollutants that are harmful to public health and the environment.** Many pollutants emitted from vehicles are currently neither measured nor regulated. This includes **tiny particles** (smaller than the current 23 nanometer particle measurement threshold) that can penetrate deep into the body⁶ and are emitted in large amounts from the tailpipe of all vehicles⁷. **Ammonia**⁸ contributes to particle pollution, and cars and vans can emit in excess of 60 mg/km; however, at present it is only regulated for heavy-duty vehicles. **Nitrogen dioxide** (NO₂), the dangerous fraction of nitrogen oxides (NO_x), needs to be regulated through a separate emission limit. For greenhouse gases, more stringent limits for **methane** and a new limit for **nitrous oxides** (N₂O) must be set. Effective regulation of dangerous chemicals, such as **formaldehyde**, **acetaldehyde** and **non-methane organic gases** (NMOG) is overdue. Finally, a robust measurement method for **volatile and semi-volatile particles** needs to be developed. All these pollutants seriously harm public health or the environment and their measurement and regulation in post-Euro 6/VI has already been assessed as feasible by the research consortium working for the European Commission^{9,10}.
- 3. Improve testing, approval and certification of vehicles to make sure emission limits apply under all possible driving conditions.** On-road (RDE) testing must be made fully representative of real world driving and cover all conditions that vehicles are

⁵ Southwestern Research Institute. Christopher Sharp, Ian Smith. (2017) [Evaluating technologies and methods to lower nitrogen oxide emissions from heavy-duty vehicles](#).

⁶ Health Effects Institute. (2013) [Understanding the health effects of ambient ultrafine particles](#).

⁷ DownToTen. Jon Andersson, et.al.. (2019) Update on sub-23nm exhaust emissions using the DownToTen sampling and measurement systems. ETH conference on Combustion Generated Nanoparticles.

⁸ Ricardo Suarez-Bertoa, et.al.. (2020) [Regulated and non-regulated emissions from Euro 6 diesel, gasoline and CNG vehicles under real-world driving conditions](#). *Atmosphere*.

⁹ Except for volatile and semi-volatile particles where a repeatable measurement method must be developed.

¹⁰ CLOVE. (October 18, 2019) Study on post-Euro 6/VI emission standards in Europe: Progress in task 2.2, development of a new array of tests. Presentation to AGVES. Brussels.

capable/designed to drive in. This requires emission limits to apply at all times, including during diesel particulate filter cleaning. **Altitude and temperature boundaries** must be aligned with the capability of measurement equipment, which is much wider than today's requirements. Raw results only should be used and no relaxed 'conformity factors' applied. Introducing a **low-load, low speed test cycle and a NO_x idling limit is needed for heavy duty vehicles** to ensure buses and trucks comply with limits under urban driving conditions. Improvements to low temperature and durability light duty type-approval tests are necessary to ensure they are fit for purpose.

4. **Ensure that emission limits are met throughout the whole lifetime of the vehicle.** At present the **EU has generally the lowest emission durability requirements globally** - i.e. the required period for cars to meet the emission limits -, only 5 years/160,000 km for light duty and 7 years/700,000 km for heavy duty. The average vehicle age in the Member States with the oldest light duty (Poland) and heavy duty fleets (Greece) are 17.3 and 18.9 years, respectively¹¹. As the exhaust emission control of older cars and trucks may no longer work, less wealthy regions often suffer disproportionately from dangerous air pollution. With all Europeans having an equal right to breathe clean air, the EU must substantially increase durability requirements and in-service conformity (ISC) testing to last as long as vehicles are on the road. Consumers must be better protected by a minimum warranty period for emission critical components and, like in the US, an emission warranty tracking database should be introduced. On-board diagnostics (OBD) must be improved and on-board monitoring (OBM) introduced to identify faulty and tampered emission control systems (up to 25% of heavy duty vehicles in the EU are tampered¹²). Along with this, a reform of Periodical Technical Inspections (PTI) is necessary to identify high emitters during regular inspections. New technologies, such as Remote Sensing, must be used to control real-world emissions and contribute to fleet market surveillance.

We can no longer afford to tinker with emission limits or set standards to protect polluting technologies. Strengthening emission limits and test procedures as well as regulating pollutants not yet regulated, is not enough. The Euro 7/VII standards must also deliver zero emission mobility as outlined in the European Green Deal by mapping out a clear pathway (in 5 year intervals) towards only zero emission new vehicle sales. The new standards must be accompanied by a robust plan for future jobs, preparing EU consumers and supply chains to phase out internal combustion engines. All new cars and vans must emit zero pollution as well as zero CO₂ emission (via EU CO₂ standards) by 2035 at the latest, and all new heavy duty vehicles by 2040.

¹¹ ACEA. (2019-2020) [The Automobile Industry Pocket Guide](#).

¹² Danish Road Safety Agency. Rene Jensen. (2019) Experience of the Danish Road Safety Agency with tampered SCR systems on HDV. Integer Emissions Summit & AdBlue Forum Europe.

1.Introduction: Past Euro standards have failed to deliver rapid and substantial cuts in air pollution

Four years on from the Dieselgate scandal which has shaken confidence in emissions regulation, work on new emission standards for light and heavy duty vehicles in the European Union (EU) has begun. A new legislative proposal under the working title ‘post-Euro 6/VI’ (informally called Euro 7/VII)¹³ has been announced by the European Commission for 2021 as part of the European Green Deal.¹⁴ This gives the European Union a new opportunity to tackle toxic air pollution, regain regulatory leadership and align vehicle emissions standards with the EU’s new ‘zero pollution ambition’ as well as the objective of net-zero greenhouse gas emissions by 2050.

Despite the adoption of more stringent emissions standards in Europe over the past three decades, improvements in air quality in European cities have been slower and more limited than projected, with reductions in some pollutants almost stagnating in recent years¹⁵ and many cities still failing to meet legal air quality limits¹⁶. 7 out of 10 inhabitants of European cities are exposed to levels of particle pollution considered unsafe by the World Health Organisation (WHO) and 7-8% inhale dangerous levels of nitrogen dioxide (NO₂)¹⁷. Road transport is a major emitter of both and a huge contributor to air pollution in Europe, especially in urban areas¹⁸.

1.1. The current Euro 6d(-temp)/Euro VI standard: still not clean on the road

The latest level of emission regulations for cars and vans (Euro 6d-temp and 6d) as well as buses and trucks (Euro VI) was partly aimed at fixing the regulatory errors that allowed poor emissions performance on the road and led to the ‘dieselgate’ scandal¹⁹. The major improvement in the stringency of the regulation was the introduction of Real Driving Emissions (RDE) tests. For the first time in Europe manufacturers were required to demonstrate that vehicles respect the emission limits on the road and not just under narrow and fixed laboratory conditions.

While this was a step in the right direction with tests showing that on-road emissions are finally beginning to decrease²⁰, major legislative loopholes still remain. Tests have repeatedly shown that

¹³ Euro standards for light-duty vehicles (cars and vans) are referred to with Arabic numerals, while heavy-duty (truck and bus) standards are referred to using Roman numerals.

¹⁴ European Commission. (2019) [The European Green Deal](#).

¹⁵ European Environment Agency. (2019) [Air Quality in Europe - 2019 Report](#).

¹⁶ European Commission. (17th of May 2018) [Air quality: Commission takes action to protect citizens from air pollution](#).

¹⁷ European Environment Agency. (2019) [Air Quality in Europe - 2019 Report](#).

¹⁸ European Environment Agency. (2019) [Air Quality in Europe - 2019 Report](#).

¹⁹ T&E. (2016) [Dieselgate: Who? What? How?](#).

²⁰ ADAC. (18th February 2019) [CF-Faktor: Braucht es noch Übergangs-Regelungen?](#).

emission limits are still not respected under all driving conditions²¹. Exclusions include diesel particle filter (DPF) ‘cleaning’ events which occur around 1.3 billion times a year in the EU and result in particle emission far in excess of the limits^{22,23} (Figure. 1). Lax regulation surrounding vehicle design and anti-tampering measures have resulted in the widespread use (among customers and fleet operators) of devices designed to disable the emission control system resulting in huge emissions of NOx²⁴. It's estimated that between 10-25%^{25,26} of European trucks are affected. Furthermore, damaged or removed diesel particle filters continue to be a problem for both light duty and heavy vehicles.²⁷ The issues outlined above are only some of the problems that must be addressed in order to reign in vehicle emissions.

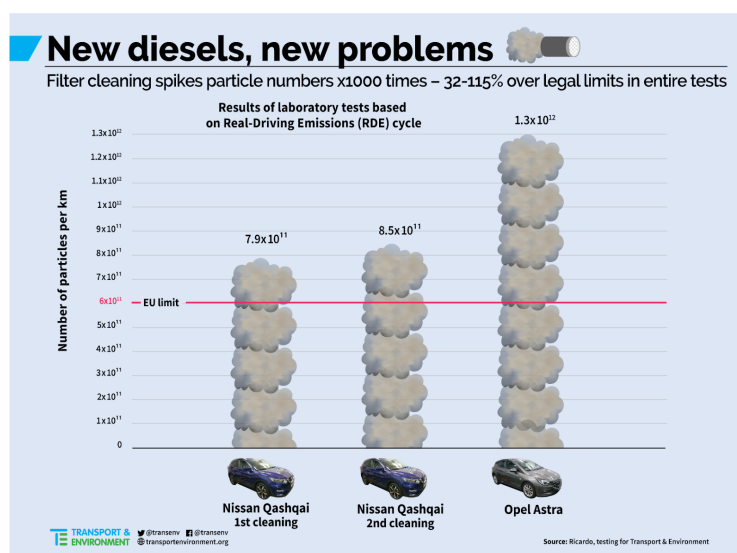


Figure 1. Even the latest Euro 6d-temp diesel cars don’t comply with the emission limits at all times; testing by T&E shows that the particle number emission limit is exceeded on tests during which a diesel particle filter (DPF) cleaning (regeneration) event takes place.

²¹ Ricardo Suarez-Bertoa et.al. (2020) [Regulated and non-regulated emissions from Euro 6 diesel, gasoline and CNG vehicles under real-world driving conditions. Atmosphere.](#)

²² T&E. (2020) [New diesels, new problems.](#)

²³ JRC. Giechaskiel. B. Lahde. T. Suarez-Bertoa. R. et al. (2018) [Particle number measurement in the European legislation and future JRC activities. Combustion Engines.](#)

²⁴ Opus. (28th of June 2019) First results of the emissions monitoring program in Madrid, Car exhaust and environmental policies. LIFE GySTRA project 2nd event. Madrid.

²⁵ Spanish Guardia Civil. (28th of June 2019) Finding NOx-cheaters on the spot with remote sensing devices and operation “ONOX”, Car exhaust and environmental policies. LIFE GySTRA project 2nd event. Madrid.

²⁶ Danish Road Safety Agency. Rene Jensen. (2019) Experience of the Danish Road Safety Agency with tampered SCR systems on HDV. Integer Emissions Summit & AdBlue Forum Europe.

²⁷ Investigations in [Belgium](#) and the [United Kingdom](#) showed in the past that thousands of cars in both countries had their Diesel Particulate Filter removed.

1.2 The EU set to fall behind best technology & China and the US

Recent studies have shown that lower emission limits are already feasible using off-the shelf technology (see details in section 3.2). Some diesel²⁸ and petrol cars²⁹, on sale today, are already capable of NOx (Nitrogen Oxides) emissions of less than a quarter of the current 80 mg/km limit on the road. NOx reductions of up to 90% from heavy-duty have also been demonstrated using existing technology³⁰. However, despite large advances in emission control technology, no changes to the EU's vehicle emission limits (since they were agreed upon over a decade ago in 2007) allow laggard vehicle manufacturers to continue fitting outdated technology and polluting cities. As currently stands, the EU is on course to fall behind China in 2023 and the U.S. in 2025³¹ as both countries have already agreed significantly stricter vehicle emissions regulations. China, which has a more ambitious real driving emissions test procedure than the EU will reduce NOx limits to 35mg/km for both diesel and petrol cars (the EU's limits are still at 80mg/km and 60mg/km, respectively).

However, work on the new post Euro-6 emissions standards is finally underway giving the EU the opportunity to be world leaders in future emissions regulations, regain the regulatory credibility lost due to the dieselgate emissions scandal and set a clear roadmap towards achieving its 'zero pollution ambition' by ensuring that all new vehicles are zero emission by 2035 at the latest.

2. How to get Euro 7/VII right? The guiding principles

In order to fully seize this opportunity and deliver the commitments outlined in the European Green Deal, the EU must focus on the following overarching objectives:

- **Protect public health:** The most recent scientific evidence confirms that there is no safe level of air pollution when it comes to public health³². Therefore, pollution must be rapidly reduced at the source to respect the air quality guidelines of the World Health Organisation (WHO) anywhere and at any time, especially given that the WHO is expected to adopt stricter guidelines next year. This is crucial given that the EU air pollution limits remain above those recommended by the WHO for the smallest particles (25 vs.10 µg/m³) but even these higher limits are not respected in 77% of EU cities³³.
- **Respect the environment:** Air pollution in Europe causes biodiversity loss, damage to ecosystems and reductions in agricultural yields. It also degrades and permanently damages

²⁸ Examples include the 6d-temp Citroën C4 SpaceTourer, Kia Sportage and Renault Kadjar

²⁹ Examples include the 6d-temp Honda Jazz, Mini Cooper and Jaguar F-pace

³⁰ Southwestern Research Institute. Christopher Sharp, Ian Smith. (2017) [Evaluating technologies and methods to lower nitrogen oxide emissions from heavy-duty vehicles](#).

³¹ CLOVE. (2019) [Review of international automotive emissions regulations in light of an enhanced EU regulatory context - Draft Report](#).

³² Health Effects Institute. (21st-22nd of January 2020) [Brussels Meeting on Air Pollution and Health: Recent Advances to inform the European Green Deal](#).

³³ European Environment Agency. (2019) [Air Quality in Europe - 2019 Report](#).

historical buildings and monuments³⁴. Future legislation must avoid any environmental damage.

- **Go to zero emissions for clean air and climate:** As some pollutants from vehicles, like black carbon, harm the climate and public health, reducing air pollution saves both lives and tackles climate change³⁵. Furthermore, achieving the EU's goal of net zero greenhouse gas emissions by 2050 requires not only stopping the sale of light duty vehicles with an internal combustion engine (ICE) and high levels of heavy duty vehicles sales with zero CO₂ emissions after 2035, but also a complete phase-out of all ICEs from the existing fleet by 2050 at the latest³⁶. As such, future regulation needs to combine both clean air and climate objectives by mapping out a 'clear pathway from 2025 onwards towards zero-emission mobility', as announced in the European Green Deal.
- **Consumer protection:** Adequate protection for consumers needs to be included in future regulation to ensure that vehicle emission control systems perform as advertised for the vehicles' whole lifetime. In the case of non-compliance, the responsibility and cost of fixing the vehicles should be borne by the vehicle manufacturer and not by customers as is largely the case today. The European consumer organisation BEUC concluded in September 2019 that four years after Dieselgate began 'nearly all of the eight million car owners who bought cars equipped with a defeat device in Europe remain empty handed.'³⁷



Figure 2. The guiding principles for Euro 7/VII

³⁴ UNECE. [Air pollution puts cultural heritage at risk](#). Accessed on: 12th February 2020.

³⁵ WHO. [Air Pollution, Climate and Health](#). Accessed on: 12th February 2020.

³⁶ T&E. (2018) [How to decarbonise European transport by 2050](#).

³⁷ BEUC. (2019) [Volkswagen Dieselgate Four Years Down The Road](#).

3. The toolbox for cleaner air: detailed recommendations

3.1. Lower and fuel neutral emission limits are possible

Large reductions in emission limits are already feasible using off-the shelf technology. Data from the RDE (real driving emissions) databases run by the European³⁸ and Japanese³⁹ automobile manufacturers' associations show that large reductions in limits are feasible with technology already in use by some manufacturer's today. In March 2019, at least 59 diesel car models⁴⁰, on sale in the EU, were already capable of on road NOx emissions of less than a quarter of the current 80 mg/km limit, including during urban driving. 37 models were capable of carbon monoxide emissions of less than 10% of the current 500 mg/km limit, clearly indicating that much lower pollutant emission limits are achievable now. Further reductions are possible if lower limits force the use and development of better technology.

For heavy duty vehicles, research has shown that NOx emissions from trucks can be reduced to 10% of the current 460 mg/kWh limit over the World Harmonised Transient Cycle (WHTC) using off-the shelf technology⁴¹. Additionally, many technologies which reduce NOx emissions also reduce or have no impact on CO₂ emissions⁴². Therefore, the argument that lower NOx limits for heavy duty will lead to higher CO₂ emissions can no longer be used to argue against the setting of lower NOx standards.

Fundamentally, the emission control technology has improved substantially since the Euro 6 standards were set over a decade ago and large decreases in emission limits must be made to reflect this. At present the EU is set to fall behind China in 2023 and the U.S. in 2025 as both countries are already committed to significantly lower vehicle emission limits. In order for the EU to finally make swift progress towards its own air quality limits and the new 'Zero Pollution Ambition', **it is imperative that EU vehicle emission limits are reduced to the globally lowest level possible, as soon as possible**. To achieve this goal, **Euro 7 should be the last standard that allows any emissions** and it should map out a **clear pathway in legislation towards only zero emission new vehicle sales**. A clear roadmap to zero will provide the EU car industry with regulatory certainty and should involve the setting of strict emission limits for 2025, an even stricter ultra low limits for 2030 (subject to a review) and next to zero pollutant allowance by 2035. From 2035 onwards only zero emission light-duty

³⁸ <https://www.acea.be/publications/article/access-to-euro-6-rde-monitoring-data>

³⁹ <http://www.jama-english.jp/europe/publications/rde.html>

⁴⁰ T&E. (2019) [EU must withdraw carmakers 'license to pollute' as data shows new cars meet limits](#) based on data available in the ACEA and JAMA databases in March 2019.

⁴¹ Southwestern Research Institute. (2017) [Christopher Sharp. Ian Smith. 'Evaluating technologies and methods to lower nitrogen oxide emissions from heavy-duty vehicles](#).

⁴² ICCT. (2019) [Future heavy-duty emission standards](#). page 6.

vehicles and heavy duty vehicles (smaller than 26 tonnes) must be sold, by 2040 all new trucks must be zero emission.

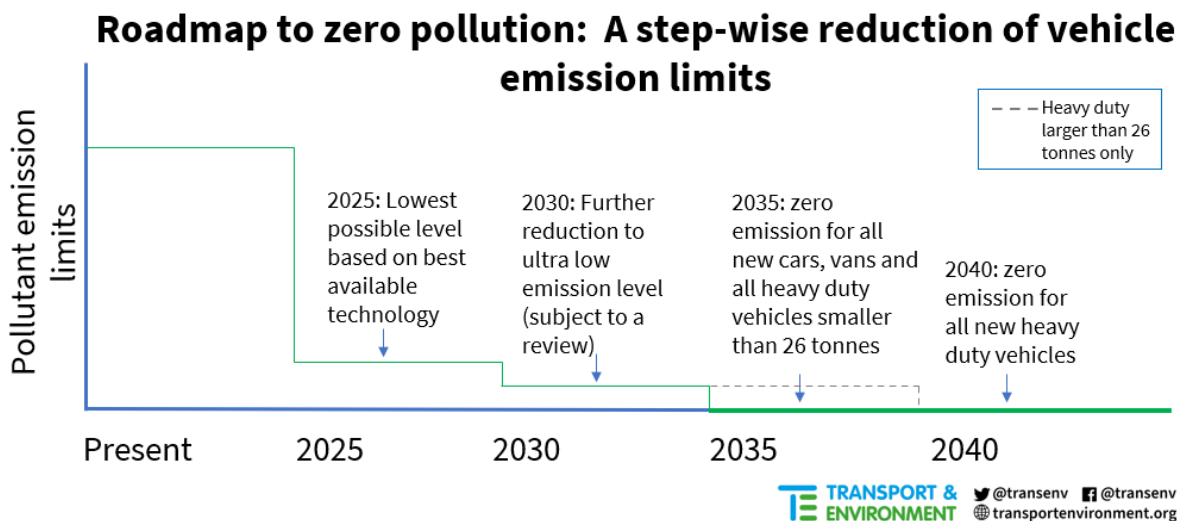


Figure 3. Timeline for the phase out of polluting internal combustion engine vehicles

Furthermore, a technology neutral approach to all pollutants should be adopted; emission limits must be respected by all vehicles including compressed natural gas (CNG), port-fuel injection (PFI), Plug-in hybrids (PHEV) and vehicles which use future advanced/synthetic fuels; as is already the case in China and the U.S.. Ultimately what matters for public health and the environment are absolute emissions, regardless of the vehicle driven.

3.2. Regulate all pollutants that harm human health, the environment and the climate

Many pollutants emitted from the tailpipe are completely unregulated but have a negative impact on public health and the environment. The following pollutants need to be effectively regulated in the future:

Solid particles smaller than 23nm: These are tiny solid particles (often smaller than a virus), emitted in large amounts from all vehicles with a combustion engine, including those powered by natural gas. Particle pollution has been linked to an increased risk of a number of serious diseases including cancer⁴³, alzheimer's⁴⁴ and cardiovascular and respiratory illnesses⁴⁵. While all particles are harmful to

⁴³ WHO. (2nd May 2018) [Air Pollution - Key Facts](#).

⁴⁴ Diana Younan, Andrew j. Petkus, et al.. (2020) Particulate matter and episodic memory decline mediated by early neuroanatomic biomarkers of Alzheimer's disease. *Brain*.

⁴⁵ WHO. (2nd May 2018) [Air Pollution - Key Facts](#).

human health, particles under 23nm could potentially be the most harmful due to the high efficiency with which they are deposited in the lungs⁴⁶ and their potentially higher toxicity.

Ammonia: Ammonia contributes to particle pollution; each 1mg of ammonia is estimated to contribute 1mg to particle air pollution smaller than 2.5 micrometer (PM_{2.5})⁴⁷. The emissions of this pollutant are only regulated for heavy duty vehicles, despite high ammonia emissions also being emitted from certain passenger cars⁴⁸.

Nitrogen Dioxide (NO₂): Is the fraction of nitrogen oxides (NO_x), the pollutant at the centre of the dieselgate scandal, which is damaging to human health. It is currently only regulated as part of a total NO_x limit. The issue with this approach is that the fraction of NO₂ varies significantly between different vehicles⁴⁹. In order to effectively regulate the emissions of NO₂, an independent emission limit must also be established for this pollutant.

Nitrous Oxide (N₂O) and Methane (CH₄) are greenhouse gases which have very high global warming potential of 298 and 86 times⁵⁰ that of CO₂ respectively. Emissions of these gases can contribute significantly to a vehicle's total greenhouse gas emissions. While methane emission limits need to be tightened for heavy duty, methane is only poorly covered as part of a total hydrocarbon limit for light duty. No emission limits exist for nitrous oxide. To effectively limit the emission of these pollutants, direct emission limits applicable under all driving conditions must be established. Additionally, to account for their climate warming effects, they must be counted in the revised CO₂ regulation⁵¹ as CO₂ equivalents.

Formaldehyde and acetaldehyde: Are cancer-causing chemicals emitted from cars and vans which have ethanol blended into the fuel. Blending of biofuels, such as ethanol, is required by EU law with normal petrol containing up to 10% ethanol. Especially high amounts of these dangerous pollutants are emitted from vehicles which use high proportions of ethanol⁵². With flex fuel vehicles which run on up to 85% ethanol (E85) sold in the EU, emission limits for both formaldehyde and acetaldehyde need to be established. Such a limit already exists for formaldehyde in the U.S.

Non-methane organic gases (NMOG): Include chemicals dangerous to human health such as ethanol and aldehydes. These are currently regulated as part of a total hydrocarbon limit but this approach

⁴⁶ ICRP respiratory deposition model as presented by DownToTen. (2019) Particle emissions measurements on CNG vehicle focusing on, sub-23nm. TAP Conference 2019.

⁴⁷ JRC. R. Suarez-Bertoa. (2019) Current non-regulated emissions in EU. Integer Emissions Summit & AdBlue Conference. Munich.

⁴⁸ T&E. (2020) [New diesels, New problems.](#)

⁴⁹ David Carslaw. et.al.. (2019) [The diminishing importance of nitrogen dioxide emissions from road vehicle exhaust.](#) *Atmospheric Environment: X.*

⁵⁰ Based on 20 year GWP for methane and 100 year for nitrous oxide due to different atmospheric lifetimes of the pollutants.

⁵¹ For light duty vehicles regulation ([EU 2019/631](#)), for heavy-duty vehicles regulation ([EU 2019/1242](#)).

⁵² Sergio Manzetti. Otto Anderson. (2015) [A review of emission products from bioethanol and its blend gasoline.](#) *Background for new guidelines for emission control.* *Fuel.*

underestimates the total amount of these gases emitted from vehicles⁵³. In order to accurately account for all these pollutants the total hydrocarbon limit should be revised to an NMOG limit as is already the case in the U.S..

Volatile and semi-volatile particles: Are small particles, today neither measured or regulated during official tests, which condense out of cooling vehicle exhaust gases, emissions of these particles can exceed that of currently regulated solid particles⁵⁴. These particles contribute to particle pollution (PM_{2.5}), but they could also have direct adverse health effects⁵⁵. While measurement of these particles is possible, the current methods have been deemed not representative enough to include in type-approval at present⁵⁶, as the amount of particles measured is highly dependent on sampling conditions⁵⁷. However, given the large amount of these particles that can be emitted from vehicle exhausts it is imperative that a robust method of measurement is developed and implemented as for Euro 7.

The pollutants outlined above have been selected by T&E as a regulatory priority as all have serious environmental or health effects and emissions of these pollutants can be effectively curbed through implementation of direct vehicle emission limits. **Their measurement and regulation in Euro 7 has already been assessed as feasible by the CLOVE consortium including on-road measurement**^{58,59}. While there are also other dangerous pollutants emitted from vehicles such as polycyclic aromatic hydrocarbons (PAH's), these have been shown to be better regulated through other measures such as more stringent fuel standards⁶⁰.

On road emissions measurement for all future and currently regulated pollutants should be a top priority for Euro 7 to ensure continuous compliance. For the EU to really achieve its 'zero pollution ambition', **all of the above pollutants must be effectively limited through tailpipe limits under Euro 7/VII as they are dangerous to health or the environment**. These limits must be applicable to all vehicles within the light duty and heavy duty categories uniformly, regardless of fuel or vehicle technology, to avoid the technology bias which is the case today.

⁵³ Ricardo Suarez-Bertoa. Michael Clairotte. et. al.. (2017) [Intercomparison of ethanol, formaldehyde and acetaldehyde measurements from a flex-fuel vehicle exhaust during WLTC](#).*Fuel*.

⁵⁴ T&E. (2020) [New diesels. New problems](#).

⁵⁵ CLOVE. (October 18th 2019) Study on post-Euro 6/VI emission standards in Europe: Progress in task 2.2, development of a new array of tests. Presentation to AGVES. Brussels.

⁵⁶ CLOVE. (October 18th 2019) Study on post-Euro 6/VI emission standards in Europe: Progress in task 2.2, development of a new array of tests. Presentation to AGVES. Brussels.

⁵⁷ The amount of volatile/semi-volatile particles formed during on road driving is highly dependent on factors such as air temperature, humidity and air dilution.

⁵⁸ Except for formaldehyde and acetaldehyde which requires further on-road measurement development and volatile and semi-volatile particles for which the measurement technique requires development.

⁵⁹ CLOVE.(October 18th 2019) Study on post-Euro 6/VI emission standards in Europe: Progress in task 2.2, development of a new array of tests. Presentation to AGVES. Brussels.

⁶⁰ CLOVE.(October 18th 2019) Study on post-Euro 6/VI emission standards in Europe: Progress in task 2.2, development of a new array of tests. Presentation to AGVES. Brussels.

3.3. Improved testing, approval and certification of vehicles

The type-approval testing procedures must be designed in such a way as to ensure that emission limits are respected by all vehicles under all possible driving conditions:

Real-driving emissions (RDE) testing measures vehicle emissions on the road. The current testing procedure must be made fully representative of real-world driving to ensure that all vehicles meet the emission limits under **all** possible driving conditions, not just within the narrow boundaries of the current RDE test procedure. This requires the changes summarised in the below table:

Necessary improvements to on-road (RDE) testing:

	Requirements for all vehicles	Requirements for cars and vans	Requirements for trucks and buses
Emission limits	Limits must apply for all pollutants including greenhouse gases	Not to exceed limits on short urban trips	Cold start: emissions measured from 1st start of the engine
	Limits must apply on tests when DPF or LNT regeneration takes place	No minimum/maximum driving dynamics	
	Limits must apply on all sections of RDE test	No maximum cumulative altitude gain	Power threshold: no minimum load requirement
Test boundaries	Altitude and temperature boundaries at max capability of PEMS equipment	No maximum speed restriction on motorway	Mandatory minimum urban driving distance
	No specific test order	No additional conformity factor of 1.6 for extended boundary conditions	
Data processing	No conformity factor for any pollutants	Raw results only	


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[transportenvironment.org](https://www.transportenvironment.org)

Table 1. The required improvements to the on road emissions testing procedure (RDE) for light duty and heavy duty vehicles

RDE tests are not the only emissions tests that new vehicle types need to pass in order to obtain type-approval that allows their sale in the European Market. The following **laboratory type-approval tests should also be reviewed** and improved as a priority:

Light duty durability (Type 5 test): Vehicles must respect emissions limits over the whole vehicle lifetime (see details in section 3.4). Keeping this test within the EU type-approval framework is essential for ensuring emissions durability and key for identifying durability issues before cars ever enter the EU market. However, the current test is not fit for purpose. Durability is demonstrated at

160,000km which is not representative of real vehicle lifetimes in the EU. Three different procedures can be used by manufacturers to age cars for testing, two of which do not reflect the true ageing that cars undergo during real world driving⁶¹ and the durability demonstration is only a WLTP (World Light-Duty Testing Procedure) test which does not test on-road performance. To really ensure lifetime emissions durability the current procedure should be replaced with on-road ageing of vehicles to the maximum EU vehicle lifetimes, followed by a full set of emission type-approval tests including RDE testing. CO₂ as well as pollutant durability should be assessed.

The **Light duty -7°C low temperature (Type 6) test** is necessary to ensure that the emissions control system works when the engine starts from cold even at low temperatures. However, the current test⁶² is based on the outdated New European Driving Cycle (NEDC), with only carbon monoxide (CO) and total hydrocarbons (THC) measured for petrol cars. For diesels, testing is even more lax with manufacturers only having to demonstrate good NOx conversion within five minutes of test start⁶³. Given the NOx and particle pollution problems in Europe, the current tests are inadequate to ensure satisfactory emissions performance for all pollutants at low temperatures. As such, the current test procedure needs to be drastically improved by: applying uniformly to all cars and vans, updating the test from the outdated NEDC test, including the use of auxiliaries (e.g. air conditioning) and, most importantly, ensuring all pollutant limits apply and do not differ from those set for the RDE or WLTP tests.

Heavy duty engine testing: In order to ensure that emission limits are continuously met under all conditions, a new test cycle focused on low-speed, low load operation which is common in cities (e.g. delivery trucks stuck in traffic or a bus with regular stops throughout its route) should be introduced. This would help ensure that emission limits are respected by heavy duty vehicles in urban areas, which is not sufficiently covered by current tests⁶⁴. Such a test has already been proposed for use in California by CARB (California Air Resources Board)⁶⁵.

Idling standard for heavy duty: Buses, refuse trucks and urban delivery trucks can spend a significant amount of time idling. Refuse trucks are estimated to idle between 30-60% of the time⁶⁶. This type of operation can significantly increase NOx emissions⁶⁷ but is not covered by current type-approval tests. To control this source of pollution, a NOx idling limit should be introduced in the

⁶¹ JRC. (2014) [Durability demonstration procedures of emission control devices for Euro 6 vehicles](#).

⁶² The test currently includes the urban part of the NEDC test only

⁶³ The manufacturer must also provide details of exhaust gas recirculation (EGR) use.

⁶⁴ TU Graz. (2019) [Update of emission factors for HBEFA version 4.1](#).

⁶⁵ CARB. (January 23rd 2019) [Heavy-duty low NOx program workshop](#).

⁶⁶ TNO. (2018) [Tail-pipe NOx emissions of refuse collection vehicles with a EURO VI engine in daily operation in the Netherlands](#).

⁶⁷ The only substantial source of heavy duty idling data available is from the U.S. ICCT (2019) [Current state of NOx emissions from in-use heavy-duty diesel vehicles in the United States](#).

EU for heavy duty vehicles. California (CARB) already has an idling NOx limit in place which is due to be tightened to a maximum of 10g/h in 2024-2026⁶⁸.

3.4. Ensure compliance over the whole vehicle lifetime

1. Robust durability requirements and enforcement must be introduced:

- **Increase durability requirements to reflect the real vehicle lifetimes:** For air quality it is important that vehicles respect the legal emissions limits throughout the whole lifetime of the vehicle and not just during the first few years. If a vehicle is driven on the road it should obey the emission limits regardless of age or mileage. At present the EU has generally the lowest durability requirement globally, only 5 years/160,000 km for light duty and 7 years/700,000 km for heavy duty, which fall far short of vehicles' real lifetimes. The average vehicle age in the Member States with the oldest light duty and heavy duty fleets are 17.3 and 18.9 years⁶⁹, respectively. This is significantly higher than the current EU durability requirements. Therefore, to ensure lifetime emissions compliance, the EU must substantially increase the emission durability requirements of all vehicles by aligning them with real EU vehicle lifetimes.
- **Introduce an emission warranty program** for emission critical components to guarantee that manufacturer's are responsible for ensuring that emission control systems perform as advertised throughout the lifetime of the vehicle. A minimum warranty period for emission critical components should be introduced in the EU for all vehicles. This must be aligned with the full lifetime of the vehicle, including multiple ownership. As part of this the Commission must establish an EU wide emission warranty tracking database to aid the Commission and Member States in identifying compliance and durability issues. This must include pre-defined thresholds which trigger mandatory investigation and remedial action and it can be combined with the current online database put in place under RDE4 provisions for independent in-service conformity tests.. A similar system is already in place in the U.S⁷⁰ and would provide EU customers with much better protection in the case that vehicle manufacturers fail to ensure lifetime emissions compliance and should encourage manufacturers to robustly design their vehicles.
- **Improve on board diagnostics (OBD), tamper protection and introduce on board monitoring (OBM).** This is necessary to ensure that emissions control systems respect the emission limits throughout the lifetime of the vehicle and that emission critical systems are not damaged, disabled or removed. To help identify vehicle tampering, which affects up to 25% of high emitting heavy duty vehicles in the EU⁷¹, a list of emission critical faults should be clearly defined in the

⁶⁸ CARB (26th September 2019) [Heavy-Duty Low NOx Program. Proposed Heavy-Duty Engine Standards. Public Workshop.](#)

⁶⁹ ACEA. (2019-2020) [The Automobile Industry Pocket Guide.](#)

⁷⁰ U.S. Environmental Protection Agency.(2019) [Emission Defect Information and Voluntary Emission Recall Report System: A Step By Step Guide for Acquisition, Data Entry, and Submittal of Reports Under the New Electronic System and Process for Emission Defect Information and Voluntary Emission Recall Reports.](#)

⁷¹ Danish Road Safety Agency. Rene Jensen. (2019) Experience of the Danish Road Safety Agency with tampered SCR systems on HDV⁷. Integer Emissions Summit & AdBlue Forum Europe.

regulation and these faults should be stored permanently by the vehicle, as is already happening in the U.S.^{72,73}. To prevent tampering occurring in the first place, tamper protection of the emissions control system must be significantly improved as part of Euro 7 and stricter penalties for tampering must be introduced at the national level. On-board monitoring (OBM) continuously measures vehicle emissions from vehicles and should be used in the EU to monitor a wide range of pollutants. From 2022 onwards, OBM monitoring of NOx emission on heavy duty vehicles will already be mandatory in California⁷⁴.

2. Independently test and monitor vehicles throughout their lifetime:

The Commission and the Member States have been given significant powers to conduct market surveillance and In-Service Conformity (ISC) testing on light duty vehicles to ensure emissions compliance as part of the Real Driving Emissions (RDE) package 4 legislation. Once the new powers kick in in September 2020, the Commission should make full use of them and regularly test vehicles, particularly for emissions and road load verification. However, to really ensure lifetime compliance, the testing requirements need to be aligned with the durability requirements (see above) and extended to reflect the whole lifetime of the vehicle, not just between 15,000-100,000km and up to 5 years which is required as present.

For heavy duty, the in-service testing responsibility needs to be taken out of the manufacturers' hands and undertaken by the Commission and the Member States, as is already the case for light duty. Only independent market surveillance and In-Service Conformity testing⁷⁵ can make sure that emission limits are respected at all times. The minimum mileage requirement of 25,000 km before in-service conformity testing should also be reviewed downwards. Testing requirements for all vehicles should be extended to include CO₂, fuel consumption and electric range (with electric range for zero emission trucks brought within VECTO⁷⁶ without delay). All raw test data from market surveillance programmes should also be made available to the public through a database managed by the Commission.

3. Roadworthiness must be ensured and the EU framework must be updated:

- **Periodic Technical Inspections (PTI) must be brought up to date** to ensure that they are effective at identifying broken, missing or tampered emissions control systems. Current procedures are inadequate to reliably identify these issues⁷⁷, potentially resulting in vehicles

⁷² ICCT. (2015) [Global overview of on-board diagnostic \(OBD\) systems for heavy duty vehicles](#).

⁷³ ICCT. (2016) [Review of LDV OBD requirements under the European, Korean and Californian emission programs](#).

⁷⁴ CARB. (15th November 2018) [CARB gets 'REAL' to further cut pollution from diesel and gas vehicles](#)Board.

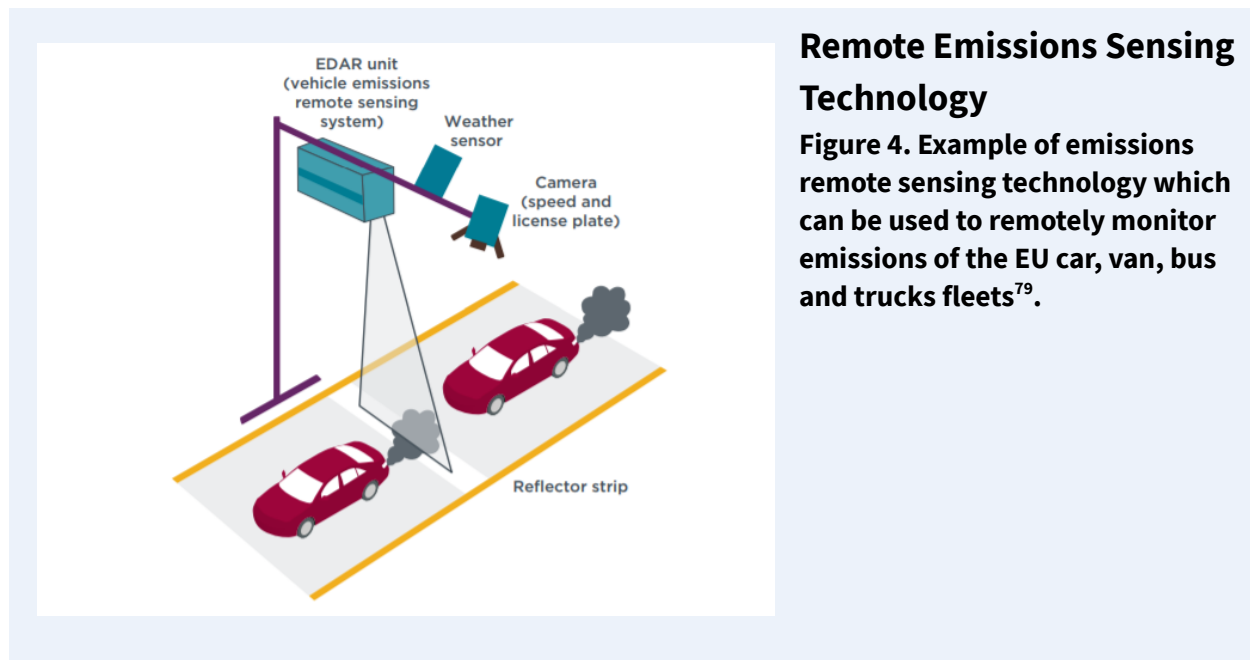
⁷⁵ CLOVE. (18th October 2019) [Progress in task 2.2: Development of new array tests', presentation to AGVES, Brussels](#).

⁷⁶ [Vehicle Energy Consumption Calculation Tool](#)

⁷⁷ CITA. (2019) [SET II project: Sustainable Emission Test for diesel vehicles involving NOx measurements, final report](#).

that could be emitting more than the legal limits despite undergoing a yearly roadworthiness inspection. Improvements to the PTI procedure should be aimed at ensuring that emission limits are respected throughout the lifetime of the vehicle and that tampering with emission control devices does not take place. The PTI Directive on minimum standards for the periodic roadworthiness tests of motor vehicles⁷⁸ should be reviewed and strengthened at the same time as the Euro 7/VII proposal, to align and comprehensively improve the EU testing requirements

- **Use remote emissions sensing as a tool to monitor emissions.** Remote sensing is a tool able to monitor the EU fleet by measuring emissions on the road as vehicles drive past the measurement equipment. This allows for quick, independent emissions screening of a large amount of vehicles at a much lower cost than Real-Driving Emissions testing. The Commission should develop a harmonised remote sensing procedure and publicly accessible cross-border database of measurements which can be used by the Commission and Member States to monitor and screen the EU fleet's emissions and assist in identifying potential problem vehicles for further testing. The harmonised procedure should also allow cities to adopt remote sensing for the identification of highly polluting vehicles for early periodic technical inspection.



Remote Emissions Sensing Technology

Figure 4. Example of emissions remote sensing technology which can be used to remotely monitor emissions of the EU car, van, bus and trucks fleets⁷⁹.

⁷⁸ [Directive 2009/40/EC](#)

⁷⁹ Graphic from ICCT. (2018) [Remote sensing of motor vehicle exhaust emissions](#).

4. Non exhaust emissions cannot detract from setting robust tailpipe limits but should be regulated

Particle emissions from non-exhaust sources such as tyre and brake wear are steadily gaining more attention, but this should not detract from setting robust new tailpipe emission standards for particle pollution. However, future regulation should also tackle emissions from tyres and brakes to ensure that particle pollution from all sources is reduced to the lowest levels possible.

Tyre wear from all vehicles should be limited as far as possible, potentially through measures such as inclusion of information on abrasion on tyre labels⁸⁰. However, given that friction is a key property of tyres, it will be hard to ever eliminate tyre particle pollution completely whereas particle pollution from the tailpipe already can be zero. It is also important to bear in mind that the size of particles released from tyres is usually much larger (>1000 nm) than those typically emitted from car exhausts⁸¹ and these larger particles are deposited in the lungs and airways with a much lower efficiency⁸² so are likely to have a less damaging health impact.

While all tyres release particles, there is a **common misconception that electric cars release more than conventional cars** with an internal combustion engine due to the (usually) higher mass of these vehicles. However, what is often not taken into account is that electric vehicles (EVs) are usually fitted with tyres specially designed for EV use, i.e. designed to cope with the specific demands of an EV including larger forces at the tyre and weight. Also, at the moment, there is simply not enough data on particle emissions from tyres to substantiate claims that EV cars emit more, a view also shared by the UK's Society of Motor Traders and Manufacturers⁸³. It may be that in fact the opposite is true: recently, the Tyre Development Manager of Finland-based Nokian tyres even stated that tyre wear on electric cars is lower than conventional ICE vehicles due to better traction control⁸⁴.

Similarly, **emission limits for brakes should be included in the future emissions regulation** to limit their release as far as possible. This is already under investigation by the CLOVE consortium⁸⁵, tasked by the European Commission to investigate the future vehicle emissions regulation. It should be noted that the UN Particle Measurement Programme's (PMP) Informal Working Group on

⁸⁰ EPRS. (2019) [New EU rules on labelling of tyres.](#)

⁸¹ Air Quality Expert Group. (2019) [Non-exhaust emissions from road traffic.](#)

⁸² ICRP respiratory deposition model as presented in DownToTen.(2019) Particle emissions measurements on CNG vehicle focusing on sub-23nm. TAP Conference.

⁸³ Air Quality News. (9th of March 2019) [Air pollution from tyres up to 1,000 times worse than from exhaust, claims study.](#)

⁸⁴ Nokian Tyres. (21st November 2019) [There is a common misconception related to electric cars- in reality tyres will last for a long time.](#)

⁸⁵ CLOVE. (4th February 2020) Study on post-Euro 6/VI emission standards in Europe (Part B). Presentation to AGVES. Brussels.

Non-Exhaust Emissions considers, based on industry data⁸⁶, that the use of regenerative braking on electric and hybrid vehicles will reduce both particle mass and number emissions from brake wear by more than any increase due to increased vehicle mass⁸⁷. This suggests that electrification is beneficial by reducing particle emissions from brake wear and that non-exhaust emissions should not be used as an argument against electrification. Furthermore, several solutions for reducing brake wear particle emissions have already been developed including by the EU funded LOWBRASYS project⁸⁸ which was able to achieve a 50% reduction in the emission of micro and ultrafine particles through the use of novel brake pad and disc materials, alternative breaking strategies and a particle capture system. The introduction of testing and limits for brake wear emissions as part of Euro 7 will drive the adoption of these new technologies and ensure the reduction of particle emissions from this non-exhaust source in the future.

Conclusion

The 'post Euro 6/VI' emission standard is a golden opportunity to fix the mistakes of the past, eliminate most pollution from internal combustion engines and put the EU car industry on a path towards a truly zero pollution future as outlined in the European Green Deal. As such, EU lawmakers should finally prioritise public health, the environment and the climate by:

1. **Seizing global regulatory leadership and setting the EU vehicle emission limits to the lowest possible level based on best available technologies** and applying these limits to all powertrain technologies within the light duty and heavy duty categories without exception. The limits set must help ensure that the WHO's Air Quality Guidelines (which are expected to be reviewed downwards next year) will be met across the EU at all times and should be close to zero no later than 2035. Post- Euro6/VI regulation should be the last one allowing any dangerous pollution from vehicles in Europe.
2. **Regulating all pollutants that are harmful to public health and the environment** to ensure that the full environmental and health impact of pollution from road transport is captured and controlled by the regulation.
3. **Ensuring that all vehicles meet the emission limits for all pollutants under all driving conditions throughout the whole lifetime of the vehicle.** This should be achieved by:
 - Extending durability requirements to truly reflect real vehicle lifetimes
 - Improving the testing procedures to ensure that all possible driving conditions are covered

⁸⁶ The data is not yet publicly available

⁸⁷ Air Quality Expert Group. (2019) [Non-exhaust emissions from road traffic](#).

⁸⁸ LOWBRASYS. (2019) ['Tackling brake emissions: The LOWBRASYS project and its contribution to improving air quality and providing policy recommendations'](#).

- Improving in-use monitoring and testing of the vehicle fleet and introducing robust measures against emissions cheating and tempering throughout the whole lifetime of the vehicle

Europe is currently in the middle of a global health crisis triggered by the COVID-19 pandemic, and the health, safety and job security of workers are rightly a priority for lawmakers. This makes the objectives of post-Euro 6/VI more important than ever. Public health experts warn that polluted air probably makes people more susceptible to viruses⁸⁹ and the World Health Organisation has stated that climate change will likely increase the occurrence of infectious diseases.⁹⁰ However, strengthening emission limits and test procedures as well as regulating pollutants not yet regulated, is not enough. The Euro 7/VII standards must also deliver zero emission mobility as outlined in the European Green Deal by mapping out a clear pathway (in 5 year intervals) towards only zero emission new vehicle sales. The new standards must be accompanied by a robust plan for future jobs, preparing EU consumers and supply chains to phase out internal combustion engines. All new cars and vans must emit zero pollution as well as zero CO₂ (via EU CO2 standards⁹¹) by 2035 at the latest, and all new heavy duty vehicles by 2040.

Further information

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⁸⁹ European Public Health Alliance. (16th March 2020) [Coronavirus threat greater for polluted cities.](#)

⁹⁰ World Health Organisation. (30th March 2020) [Climate change and human health - risks and responses. Summary.](#)

⁹¹ Milieu. Scoping study for T&E. (2020) [Phasing- out sales of internal combustion engine vehicles.](#)