VEHICLE EMISSIONS IN A POST EURO-6 CONTEXT:
POLIS RECOMMENDATIONS TO THE ADVISORY GROUP ON VEHICLE EMISSION STANDARDS (AGVES)

Enabling European cities & regions to improve air quality by reducing vehicle emissions

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POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

About POLIS

POLIS is the leading network of European cities and regions working together to promote sustainable mobility through the deployment of innovative transport policies and solutions.

POLIS fosters multi-stakeholder cooperation and public-private partnerships across Europe with the aim to make research and innovation in transport accessible to cities and regions. The network and its Brussels-based secretariat actively supports the participation of POLIS members in EU-funded research and innovation projects in the field of transport. POLIS' and its members' participation in European projects allows us to create a framework which facilitates dialogue and exchange between local and regional authorities and European transport research and industry stakeholders.

The POLIS Working Group on Clean Vehicles & Air Quality addresses vehicle emissions as well as alternative fuels and related refuelling infrastructure. POLIS is involved in several European expert groups and platforms, including the EC's Sustainable Transport Forum, the Horizon Europe 2ZERO partnership, the European Road Transport Research Advisory Council (ERTRAC) and the European Electromobility Platform.

1. Road transport emissions: how do they affect citizens?

With almost three quarters of the European population living in urban areas, policy makers at the local level have different challenges to solve but also several opportunities to offer to their citizens. When it comes to transport, cities and regions want to provide services which meet citizens' mobility needs in an inclusive, fair, accessible, and flexible way. Yet, they also want their cities to be pleasant, attractive and healthy places to live, work and be in. This requires tackling many severe transport-related societal challenges, such as congestion, air pollution and safety, which pose a threat to citizens' health and well-being, and their overall quality of life.

Air pollution - coming from motorised road transport – contributes greatly to premature health loss. In 2010, The World Bank estimated that in Western Europe the deaths caused by air pollution from motorised transport almost equalled the number of road fatalities[1].

When it comes to **road safety** in Europe, decisive policies and legal initiatives have resulted in considerable reductions in road crash fatalities over the past years. In 2010, 31.500 fatalities were reported. Five years later, in 2015 this number had been reduced to 26.100 fatalities[2]. This positive trend continues, despite remaining road safety challenges[3].

Also in 2015, research from the International Council on Clean Transportation (ICCT) showed that about 40.000 premature deaths in Europe can be linked to tailpipe emissions from road vehicles (Particulate Matter $PM_{2,5}$ and Ozone resulting from Nitrogen Oxides NO_X)[4]. In 2012, the International Agency for Research on Cancer of the World Health Organisation (WHO) had already pointed out that there is sufficient evidence in humans of the carcinogenicity of diesel exhaust. Diesel exhaust is a cause of lung cancer and an increased risk of bladder cancer was also noted[5]. In addition, the most recent data from the European Environmental Agency (EEA) shows that transport is responsible for more than two thirds of all NO_X emissions[6].

"In 2015, research from ICCT showed that about 40.000 premature deaths in Europe can be linked to tailpipe emissions from road vehicles"

While the **harmful impact** of road crashes on health is brutally direct, the direct link between air pollution and health generally remains hidden in scientific reports. When looking at health impacts, injuries, premature deaths, and fatalities, an obvious question arises: Does it really matter whether road crashes or pollution cause these health effects? Road motorised transport emissions and road safety challenges are equally important and deserve equal attention.

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1 Transport for health: the global burden of disease from motorized road transport. http://documents.worldbank.org/curated/en/984261468327002120/Transport-for-health-the-global-burden-of-disease-from-motorized-road-transport

2 https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/vademecum_2018.pdf

3 2015 road safety statistics: What is behind the figures? https://ec.europa.eu/commission/presscorner/detail/en/MEMO_16_864

4 Assessment based on data from 2015. The study only takes tailpipe PM 2,5 and ozone (resulting from NOX-emissions) into account: https://theicct.org/publications/health-impacts-transport-emissions-2010-2015

5 https://www.iarc.fr/wp-content/uploads/2018/07/pr213_E.pdf

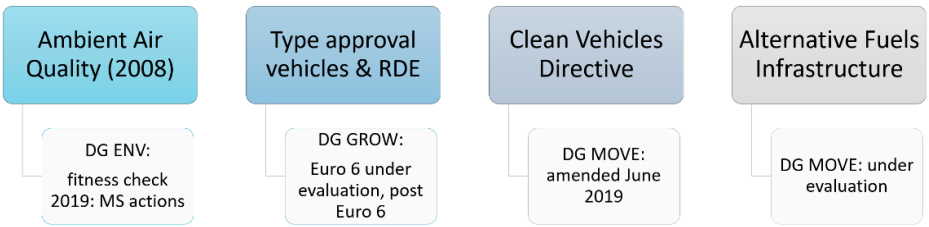
6 https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-air-pollutants-8/transport-emissions-of-air-pollutants-8

2. Efforts to improve air quality: from EU legislation to local implementation

2.1 Efforts on the European level

At the European level, several **policies and legislative frameworks** aim **to improve air quality and reduce greenhouse emissions** (GHG). The ambient *Air Quality Directive* 2008/50/EC[7] establishes zones which must manage and respect certain pollutant limit values (even if some thresholds defined are less strict than those set by the WHO). Member States (MS) are responsible for meeting the provision of the Directive[8]. The goal to protect citizens' health with air quality standards is commendable, but cities and regions in Europe struggle to meet them. Traffic emissions are a major (and in case of NO_2, the main) source for local air pollution. Research shows that combustion engine driven (ICE) vehicles emit significantly more in reality when compared to the type-approval values, which puts local and regional authorities in a difficult position to act. Therefore, a better strategy is needed regarding vehicle emission standards, which allows for better monitoring and more effective enforcement.

The '*Clean Vehicles' Directive'* (EU) 2019/1161 on *the promotion of clean and energy-efficient road transport vehicles*[9] sets emission thresholds for both CO_2 and air pollutants for clean heavy-duty and light-duty vehicles (categories M_1, M_2 and N_2).



7 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&from=en
8 https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health#:~:text=The%20current%20WHO%20guideline%20value,the%20health%20effects%20of%20gaseous.
9 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L1161&from=EN

Local authorities can contribute to reducing emissions, by developing **air quality plans**, which in combination with **Sustainable Urban Mobility Plans** (SUMPs)[10], set specific goals and identify measures that can be put in place to monitor, reduce, and control air pollutants. Examples include Urban Vehicles Access Regulations (UVARs), the procurement of clean vehicles for public fleets and incentives for and promotion of clean vehicles for other captive fleets and the wider public. However, as UVAR schemes are in most cases based on the Euro standards, their effectiveness strongly relies on the guarantees offered by the type-approval framework. This has shown to be insufficiently reliable, leaving cities and regions with no tools to protect citizens from harmful vehicle emissions.

POLIS welcomed the goals laid down in the *2011 White Paper*[11] to 'halve the use of 'conventionally fuelled' cars in urban transport by 2030 and to phase them out in cities by 2050'. This is essential to reach a reduction of 60% of GHG emissions in transport. To facilitate this transition, Directive 2014/94[12] has been put in place with regulations regarding alternative fuels and fuelling infrastructure. In this Directive, urban areas have been identified as key for the deployment of electric charging infrastructure. In order to achieve this intended transition, a level playing field is required in which all vehicles need to comply with the emission limits, also in real driving conditions.

EU efforts need to be recognised, as several **legislative measures to improve emissions** testing were already under consideration before Dieselgate. The scandal did accelerate the adoption of the Worldwide Harmonised Light Vehicle Test Procedure (WLPT), as well as legislation of Real Driving Emissions (RDE)[13] packages and the new type-approval framework laid down in Regulation (EU) 2018/858, which resulted in a better oversight by the EC and Member States. Third parties now have the right to independently conduct emission tests and Member States have the obligation to test vehicles in circulation. WLTP, and especially the introduction of RDE with In-Service Conformity (ISC), allows for improved emissions testing[14].

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10 https://eur-lex.europa.eu/resource.html?uri=cellar:82155e82-67ca-11e3-a7e4-01aa75ed71a1.0011.02/DOC_4&format=PDF

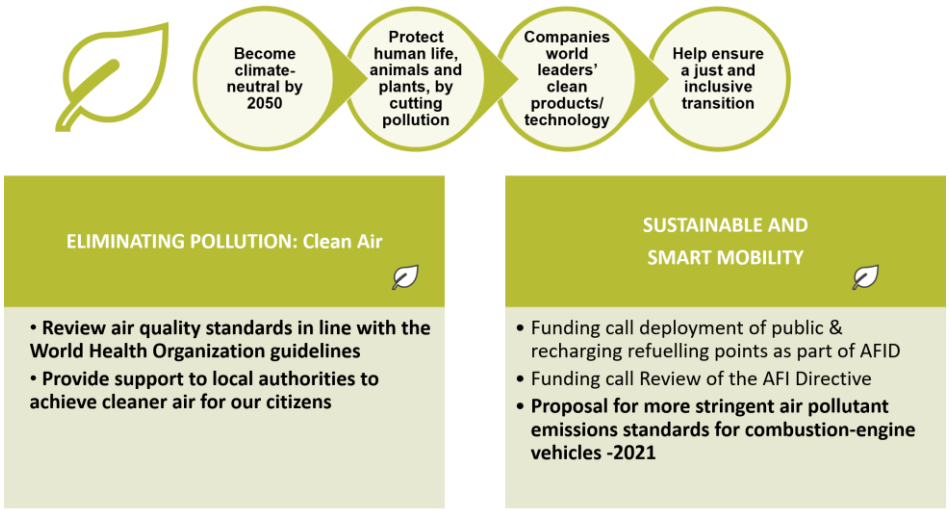
11 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN

12 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0094&from=en

13 Real Driving Emissions test, this is a new emissions test in which vehicle emissions are monitored during a testcycle driven on the road instead of in laboratory

14 The EU's response to the "dieselgate" scandal (European Court of Auditors (February 2019). Retrieved on 4 March 2020 https://www.eca.europa.eu/lists/ecadocuments/brp_vehicle_emissions/brp_vehicle_emissions_en.pdf

The **reduction of vehicle emissions** and the further **roll-out of alternatively fuelled vehicles in cities and regions** is addressed in several European directives, regulations and communications proposed by different European Commission Directorates and discussed and approved by several expert groups, European Parliament committees, etc. This in its own presents a challenge for local authorities, which depend on coherent, consistent, and coordinated European policies and their prompt and clear transposition by Member States. With the Green Deal, a new opportunity presents itself to give direction and achieve the clear goals to 'make Europe climate neutral by 2050, boosting the economy through green technology, creating a sustainable industry and transport and cutting pollution'[15]. The Green Deal has identified actions to reach these goals including[16]:



Many cities, regions, and industry sectors, including the automotive sector, have been severely impacted by the **COVID-19 crisis**[17]. The Green Deal is prompted to 'take a centre stage of the EU recovery efforts'[18]. Discussions are also taking place on 'green vehicle replacement programmes', as explained in a recent briefing note from the ICCT[19]. When comparing GHG reductions and air pollutant emissions from old and

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15 https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF
16 https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_2&format=PDF
17 https://www.acea.be/news/article/eu-auto-industry-actions-to-fight-covid-19
18 https://www.europarl.europa.eu/news/en/press-room/20200419IPR77407/eu-covid-19-recovery-plan-must-be-green-and-ambitious-say-meps
19 https://theicct.org/sites/default/files/publications/Vehicle-replacement-programs-COVID-Jun2020.pdf

recent (2020) ICE cars and battery electric vehicles (BEV), results showed that real world CO_2 emissions of the average new ICE car are similar to the ones of old cars. The real gain in CO_2 reduction is achieved with BEVs. In addition to being the climate-friendly alternative, BEVs do not cause any NO_X emissions. Focusing on BEVs could not only help to achieve the environmental goals as set in the Green Deal, it could also strengthen the innovative and market position of European vehicle manufacturers.

"Urban areas account for 23% of all CO2 emissions from transport and many still struggle to improve air quality"

POLIS welcomes the idea of taking the **Green Deal** as the backbone of the EU recovery plan from the COVID-19 crisis, and supports the actions which help Europe to take a front position in different industry sectors, while at the same time benefitting the health and well-being of its citizens. Together with its member cities and regions, POLIS already promotes innovative transport solutions in urban areas and as a network will contribute, at this crucial moment, to the discussion on better and more reliable air pollutant emission standards for ICE vehicles.

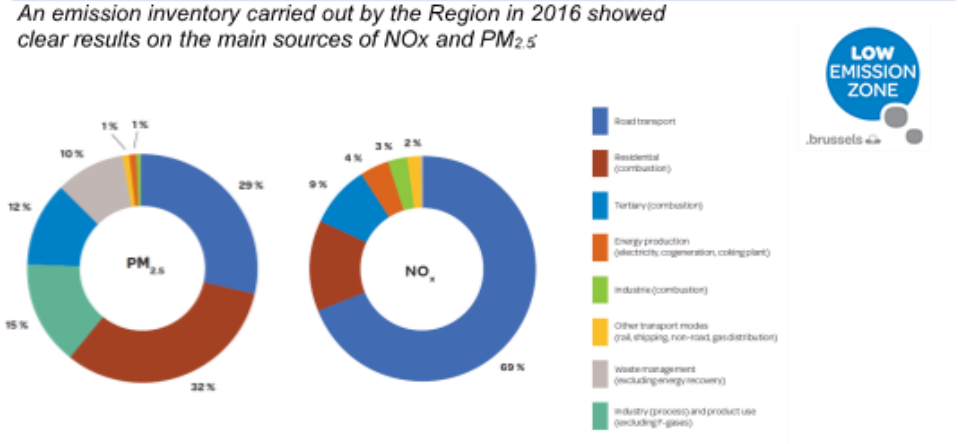
2.2 The contribution of cities and regions to reducing air pollution from road transport

As mentioned in the Communication '*Together towards competitive and resource-efficient urban mobility*' (COM (2013) 913)[20], of the current Urban Mobility Package, European cities generate over 80% of the Union's GDP. With big challenges to tackle, such as the heavy reliance on the use of conventionally fuelled private cars and the slow shift towards more sustainable transport modes, urban areas account for 23% of all CO_2 emissions from transport and many still struggle to improve air quality. On the other hand, thanks to their high population densities and high share of short distance trips, urban areas have a big potential to 'move towards low-carbon transport' and to cut emission pollutants through walking, cycling, public transport – and the early market introduction of vehicles powered by alternative fuels.

[20] https://eur-lex.europa.eu/resource.html?uri=cellar:82155e82-67ca-11e3-a7e4-01aa75ed71a1.0011.02/DOC_4&format=PDF

As previously mentioned, when it comes to reducing vehicle emissions, many cities have been implementing **UVARs** including (ultra) Low Emission Zones (LEZ) or even already plan for Zero Emission Zones (ZEZ)[21]. One example is the LEZ of the Brussels region[22]:

An emission inventory carried out by the Region in 2016 showed clear results on the main sources of NOx and $PM_{2.5}$



A LEZ was established in 2018, covering the entire Brussels Region and focusing on cars, vans, mini-buses and coaches. Access criteria depend on fuel and Euro standards. Until now, the impact on NO_2 concentration levels has not been evaluated and the emission from Euro 6 vehicles is not yet addressed. By the year 2025, all diesel vehicles except Euro-6 and GNG, LPG, petrol Euro 3-6 will be forbidden to enter the LEZ. New criteria will be applied after 2025. The ambition is to ban diesel vehicles by 2030 and GNG, LPG and petrol vehicles by 2035. Moreover, the goal of the Brussels Region is to follow WHO standards for air quality.

London will implement a central London ZEZ from 2025, a wider ZEZ from 2035 and a London-wide ZEZ in 2050. Ultra-Low Emission street schemes are also being implemented across different London boroughs[23]. The city of Paris has also introduced a LEZ in different phases. In the last phase (5), which will run from 2024 to 2030, no diesel vehicles will be allowed to enter. Petrol or gas cars or light-duty vans should be at least Euro 5, registered from January 2011. And from 2030, only electric and hydrogen fuel cell vehicles will be allowed to circulate[24].

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21 https://urbanaccessregulations.eu/

22 Presentation Brussels Environment, POLIS Working Group Clean Vehicles & Air Quality, 20200205 & https://lez.brussels/medias/lez-note-en-vdef.pdf?context=bWFzdGVyfGRvY3VtZW50c3w4NzEwNjI3fGFwcGxpY2F0aW9uL3BkZnxkb2N1bWVudHMvaGFiL2gzYy84ODAxNjI2Njg1NDcwLnBkZnxlNGNhYmZmYThmYjQ0MTczODE3MmU3MzYyYzc2ODdiOGZjYWFkOGYyNzNjZWM4OTA4MmJiYmU2NTgwMGVhOGFl

23 Presentation Transport for London, POLIS Working Group Clean Vehicles & Air Quality, 20200205

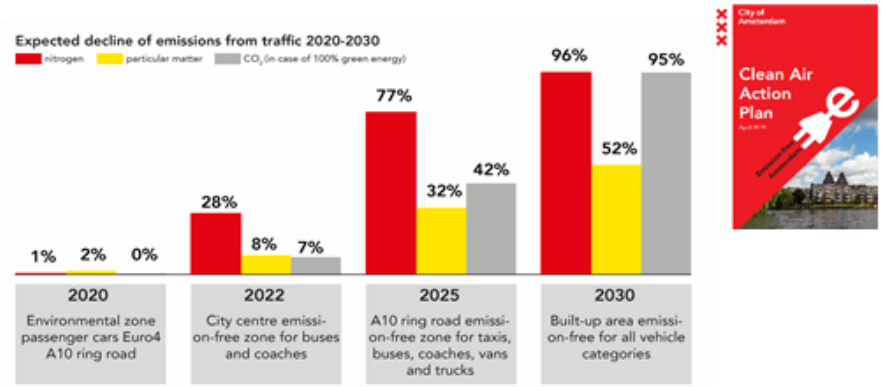
24 https://urbanaccessregulations.eu/countries-mainmenu-147/france/paris

Thanks to such ambitious LEZ or ZEZ, many local authorities will reach the 2011 White Paper goal earlier than planned, but they also heavily depend on EU Euro standards legislation and on the type of vehicles being sold now and in the future.

"Cities heavily depend on the type of vehicles being sold now and in the future"

This is illustrated by the strategy of the city of Amsterdam, which is a good example of reducing emissions by investing in and promoting BEV[25].

The city of Amsterdam released its Clean Air Action Plan in 2019. The aim is to improve air quality so that by 2030 the average life expectancy of its citizens is extended by 3 months. It also aims to comply quickly with the EU's air quality standards, but the ultimate target are the pollutant limits set by the WHO guidelines. The city's LEZ will become a ZEZ by 2030, with the expected reduction in emissions for road transport as shown below:



This also implies a continued investment in and promotion of electric mobility. It is well-known that the city of Amsterdam is a front-runner in this field, with the largest AC charging network in the world, based on a demand-driven approach. The city is also looking at high-speed charging and the adaptations needed in terms of electricity needs and capacity. Public procurement of electric vehicles and facilitating and providing incentives to private fleet operators, have been also a key aspect of their electromobility strategy.

Despite these ambitious objectives, around 60% of combustion engine vehicles will still be circulating in the city in 2030, due to the fleet renewal that can take up to 15 years. Therefore, Amsterdam's zero emission policy goes hand in hand with current and post-Euro 6 regulations. Having an upcoming stringent regulation will support the city's goals. On the other hand, continued investment in fossil fuelled vehicles could hamper the much-needed investments in the further development and deployment of new (emission-free) technologies.

More actions are being taken at the local level to lower vehicle emissions, such as the promotion of **plug-in hybrid heavy and light-duty vehicles** (PHEVs). Combined with geofencing, PHEVs could automatically switch in real-time to an electric mode when entering a specific area (e.g. a LEZ)[26]. PHEVs have also been promoted as an intermediate step before shifting to full-electric vehicles, for example to address range anxiety. Nevertheless, there are important aspects to consider when driving PHEVs in cities, especially for light-duty models. Considering that the average car

[25] Presentation City of Amsterdam, POLIS Working Group Clean Vehicles & Air Quality, 20200205
[26] https://www.greencarcongress.com/2019/10/20191028-ford.html

trip in urban areas in Europe is 20 km[27] and that the latest BEV models can have an autonomy of 200 km or above[28], range anxiety is less of a problem. Another aspect is that the benefits of PHEVs on CO_2, energy consumption and pollution are not yet clear. When tested under laboratory conditions, PHEVs provided substantial environmental advantages when compared to conventional ICE vehicles. However, the official type approval values did not seem to be achievable in real traffic and under specific usage modes with an empty battery[29]. In any case, several cities are now opting for the procurement and promotion of BEVs.

3. Why are all these efforts still not enough? Vehicle emissions legislation and interpretation

Despite the aforementioned efforts by the EU and by cities and regions, we still risk to be confronted with **unacceptable emissions in real driving conditions**. This is due to the fact that the current legal framework fails to regulate liability in case emission problems are brought to light. OEMs make use of the loopholes in the current legislation that allow them to evade their responsibility. Despite the new testing regulations, shortcomings in testing procedures, limited enforcement and a lack of transparency are persistent. Tampering is still a common problem and needs to be controlled in a proper manner.

3.1 Dieselgate and persisting problems

Until **Dieselgate** broke lose in 2015, indications that vehicles over-emitted in normal driving conditions were thought to be related to emission tests not being representative for real-world driving behaviour. However, the emissions scandal revealed that illegal defeat devices had been installed by OEMs to cheat the emission tests. The legal framework has failed to ensure that real-world vehicle emissions comply with the limits during the

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27 https://www.researchgate.net/publication/304529795_Mobility_Data_across_the_EU_28_Member_States_Results_from_an_Extensive_CAWI_Survey

28 https://ev-database.nl/#sort:path~type~order=.rank~number~desc|range-slider-range:prev~next=10~1000|range-slider-bijtelling:prev~next=25~1400|range-slider-acceleration:prev~next=2~23|range-slider-fastcharge:prev~next=0~1500|range-slider-lease:prev~next=250~2750|range-slider-topspeed:prev~next=110~450|paging:currentPage=0|paging:number=9

29 https://www.toi.no/getfile.php?mmfileid=44975

entire lifespan of vehicles. Even now, years after Dieselgate, not all vehicle models concerned have been retrofitted and roadside measurements and research indicate that recently type-approved vehicles still do not always comply with the emission limits under normal driving conditions.

In 2018, **a new type-approval framework** was published, which will enter into force in September 2020. However, the European Court of Auditors reported[30] in 2019 that manufacturers can still attempt to employ technologies or strategies to fit the RDE test parameters, optimising vehicles to pass the test rather than actually reducing overall emissions. The report also noted that outside the RDE boundary conditions, vehicles run the risk of over-emitting. Unfortunately, those boundary conditions do not cover all normal driving conditions in Europe. While the intent of RDE was to cover 95% of the driving conditions, the combined application of all RDE-boundary conditions results in significantly less than 95% of actual driving conditions[31].

The current legal framework to keep emissions in check has failed mainly due to the following reasons:

1. Limited liability of manufacturers
2. Shortcomings in testing procedures, limited enforcement & problems with vehicle tampering

3.1.1. Shortcomings in the EU legislation and limited liability of the manufacturers

The **liability of an OEM** is limited by the type-approval system, which shifts the responsibility for the real-world emission performance from OEMs towards the government (with the Granting Grant Type Approval Authority - GTTA to approve the models and the EC to design legislation with regard to limits, testing, procedures, etc). Assessing engine operation schemes, post-emission treatment technology and design, emission reductions strategies etc. require highly specialised expertise, which is often not present in national or regional governments. Yet, they are responsible as type- approval authority (TAA) and as such they play a key role in granting market access for vehicles EU-wide. There are currently 33 active type-approval authorities[32] in Europe. It is unrealistic to expect all these institutes to develop the sufficient level of expertise required to approve vehicles and conduct the required investigations. It is also an

[30] https://www.eca.europa.eu/lists/ecadocuments/brp_vehicle_emissions/brp_vehicle_emissions_en.pdf
[31] https://repository.tudelft.nl/view/tno/uuid:b0ff9bd6-41d0-4d88-89fe-012321e955be
[32] https://ec.europa.eu/docsroom/documents/39594

inefficient approach to arrange well-organised market access for technically complex products with a significant potential impact on health, environment and safety. The European Parliament Committee of Inquiry into Emission Measurement in the Automotive Sector (EMIS) describes substantial variations in human and financial resources between TAA's in its 2017 report[33]. Questions are also raised about the level of independence by which GTAAs approve vehicles. In the new type-approval legislation, stricter rules involving financing and fees have been adopted. However, given the economic impact of the vehicle industry, national interests can still conflict with European public and environmental health interests.

The **fragmented landscape** of various national/regional authorities to control access to the single market also complicates an effective and uniform EU-wide response in case emission problems are found. For example, Germany has required German OEMs to participate in an exchange programme and hardware retrofits, but this programme is not applied elsewhere[34]. The lack of coordinated collaboration and transparency (e.g. in approval and registration of Auxiliary Emission Strategies[35]) also hampers independent and market surveillance testing.

The liability of OEMs is further limited by the concept of the **'useful lifecycle' of vehicles**, which does not correspond to the actual lifecycle. Another important issue is that conformity checks are limited to vehicles that drove < 100.000 km or are less than 5 years old, effectively reducing the liability of the OEM. Data from the European Automobile Manufacturers' Association (ACEA)[36] shows that the average fleet age of passenger cars in the EU is 10,8 years. Statistics show that the average lifecycle of passenger cars is increasing. For example, in Belgium which is known to have a relatively young fleet, the average age of vehicles taken out of circulation is 16,5 years[37].

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33 https://www.europarl.europa.eu/doceo/document/A-8-2017-0049_EN.pdf

34 https://www.europarl.europa.eu/doceo/document/TA-8-2019-0329_EN.html

35 Auxiliary emission strategies (AES) allow a manufacturer to have a vehicle approved which causes significant emissions in specific conditions. This needs to be approved by the GTAA. These arrangements are not made public, so it is impossible for the consumer or the government to know in which conditions these vehicles struggle to meet acceptable emission levels.

36 https://www.acea.be/uploads/publications/ACEA_Report_Vehicles_in_use-Europe_2019.pdf

37 Data provided by Febelauto

3.1.2. Failing of the testing procedures, limited enforcement & problems with vehicle tampering

The current framework dictates **well-defined testing procedures and conditions for different stages**. The most stringent testing happens when a prototype is type approved. In practice, the liability of the OEM ends once compliance with a (limited) official test is ensured. Apart from the liability issues described earlier, this is also due to problems regarding testing procedures prescribed in later stages:

- **conformity checks by OEMs** (and GTAA): not considered to be effective due to the potential conflict of interest;
- **market surveillance and in-service conformity testing**: expensive, technically complex and limited by very restrictive requirements on test vehicles and conditions;
- **periodic technical inspection (PTI)-tests**: obsolete or too weak in terms of emissions testing.

The following issues with the current framework limit the **effectiveness** of emission tests in guaranteeing an acceptable emission performance of vehicles on the road:

a) The current testing procedures allow the OEM to design and **configure vehicles to merely pass the test**, rather than to aim for the lowest emissions possible in real-world conditions. Even after updating the New European Driving Cycle (NEDC) to WLTP and the introduction of the RDE-test on-road, defeat devices could still remain undetected. OEMs can still optimise vehicles for the testing procedures, rather than strive for minimal emissions in real-world conditions. This point has also been made by the European Court of Auditors[38].

   More than detailed technical descriptions of testing procedures, there is a **need for general principles** which consist of **unambiguous, clear and measurable requirements** for the desired real-world environmental performance of vehicles.

b) **Independent testing or market surveillance tests** are complicated by very hard to meet or to prove prerequisites, which makes testing unnecessarily expensive and complex and in practice limits the liability of the OEM. The **burden of proof** in case emission issues are found lays unilaterally with the testing party. Even when such proof is produced, in practice the OEM can often avoid responsibility because

[38] https://www.eca.europa.eu/lists/ecadocuments/brp_vehicle_emissions/brp_vehicle_emissions_en.pdf

the problems generally reside outside the durability criteria or do not fall within the strict requirements laid down in the type-approval framework.

c) The **fragmented landscape of type-approval authorities** in Europe seems to offer OEMs many opportunities to enter the single market but leaves few options for local and regional governments to act decisively and demand solutions from the OEM in case emission problems arise.

d) There is a **lack of effective periodic technical inspection (PTI) testing procedures** to detect vehicle tampering and harmful defects. On-board diagnosis (OBD) checks are unreliable since they can be easily manipulated, opacity testing does not detect particulate filter removal and there is no NO_X-emission test in place (especially relevant to avoid issues with the selective catalytic reduction (SCR) system, lean NOx traps (LNT) and exhaust gas recirculation (EGR) or degradation in 3-way catalysts).

3.2 Consequences for European local authorities and their citizens

In addition to the limitations and loopholes described in the previous section, and despite the improvements in the latest light-duty vehicle emission legislations (euro 6d), there are **persistent problems** that will always translate into **higher pollutant emissions** than what can actually be achieved:

a) **The EU emission targets are less stringent when compared to other parts of the world,** proving that the available diesel and petrol engines can already do more to reduce emissions and that there is simply no technical reason for not implementing at least the same limits in Europe. Compared with other world regions, European legislation and regulations present important differences[39 40 41 42 43 44]:

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39 https://reader.elsevier.com/reader/sd/pii/S1364032118300182?token=CB7DA3924B2F278A64949B30FD98105489D7D1996D4FA90774E28857C5C586718D5694426A3C06C50F3153A7A744D98A

40 https://theicct.org/sites/default/files/publications/Post_Euro6_standards_report_20191003.pdf

41 https://reader.elsevier.com/reader/sd/pii/S001393511930369X?token=0F5D4A6DF1EA62BFE3AB0E816050438791EDD951DDC66590CBABCE25295EBC564F8F445FF57CCCC4EB6850F949EC2EB5

42 https://reader.elsevier.com/reader/sd/pii/S0306261916307152?token=C843CD2673DAA9B78485BB3D90582F2C0F1927E0D70BED10BB8A9FE40B9229C6A79B678229354282E4EBFE147602CC70

43 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6143386/

44 https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/EMIS/DV/2016/06-20/EMIS_questions_EmissionsAnalytics_responses_EN.pdf

	NO_x	PM	Main differences
European Union	60 mg/km (petrol) 80 mg/km (diesel) for LDVs class 1	4,5 (mg/km) for both diesel and petrol vehicles	RDE Conformity Factors (CF) for diesel vehicles of 2,1 until 2020, 1,43 from 2021. To be revised annually. Diesel vehicles could be type approved with either a LNT or a SRC system. Different taxation for petrol and diesel vehicles -unique to Europe.
US -EPA and California Low Emission Vehicle programmes	40 mg/km (both petrol and diesel) By 2020 all passenger cars and light trucks should comply with a combined limit of 40 mg/km for non-methane organic gases (NMOG) and NO_x. Will gradually phase in the limit to approx. 19 mg/km by 2025.	4,5 mg/km 1.9 mg/km by 2028	Right engine calibration can cover practically every driving situation of NO_x production. Lean NO_x traps (LNT) and selective SRC systems for vehicles commercialised since the late 2000s. Fuel neutral approach No difference between light-duty vehicles from light commercial vehicles
China	60 mg/km to be reduced to 35 mg/km by 2023	4,5 mg/km by 2020, down to 3 mg/km by 2023 Methane (CH_4) and nitrous oxide (N_2O) are targeted separately	Fuel neutral approach

b) Other important aspects in the current **Euro 6 vehicle emission limits** are:

   a. **Ultrafine particles**: the size of ultrafine cut-off could be lowered from 23 nm to at least 10 nm, emission standards of particulate number (PN) could be made fuel and technology neutral.
   b. There are **other pollutants** that are not regulated: limits for methane (CH_4) and nitrous dioxide (N_2O) emissions are needed and could be accounted in the CO_2 standards; limits are also needed for ammonia, aldehyde emissions, volatile organic compounds (VOCs) and brake wear particles.

c) The introduction of the **WLTP** still reveals an increase in energy consumption and CO_2 emissions when compared to the NEDC, diesel vehicles being more impacted than petrol ones from the transition to WLTP.

d) The introduction of **Portable Emissions Measurement Systems** (PEMS) and **Real Driving Emissions** (RDE) testing has been unfortunately watered down to the point that its efficacity is now limited. As previously mentioned, this is related to:

   a. The **conformity factors** applied (CF) and that are supposed to consider the technical uncertainties of PEMS. Nevertheless, the technical improvements made over the past few years in PEMS are currently not sufficiently taken into account, neither the fact that for the 80 mg/km limit a CF of 1,25 could be already feasible.
   b. The **transfer function** applied to cover the engine's operation range and ambient conditions.
   c. The exclusion of **driving conditions** not considered as normal.
   d. And quite importantly, the **boundary conditions of the test** itself. Embedded in the RDE-legislation, boundary conditions are such that conditions which frequently occur are in fact disqualified.

e) The **impacts of the current LDV European legal framework** in terms of vehicle emissions and how OEMs have approached this are not only affecting the health of European citizens and their trust in the automotive industry, but also the effectiveness of the decisive measures that local authorities are taking to improve air quality. For example, most LEZ are currently technology-neutral, but as expected results are insufficient, especially for NO_X, European cities and regions will have to make extra efforts, such as using other tools which allow to monitor vehicle emissions in normal driving conditions, for example via remote sensing[45 46 47].

f) As a result of the difficulties encountered under the **type approval vehicle legislation**, and thanks to more ambitious goals in terms of air and CO_2 emission reductions, more cities and regions are planning to **ban diesel and petrol vehicles from urban areas**.

g) **Legal action** has also been taken. The cities of Paris, Brussels and Madrid have objected against the use of conformity factors which

[45] https://theicct.org/sites/default/files/publications/Remote-sensing-emissions_ICCT-White-Paper_01022018_vF_rev.pdf
[46] https://www.trueinitiative.org/data
[47] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC117894/rsd_report_online.pdf

increase the emission limit of NO_X in new cars[48] [49]. The Prosecutor's Office in Paris[50] brought a case for disabling the exhaust gas recirculation (EGR)-valve[51] in normal driving conditions in NEDC approved diesel cars. On 30 April 2020, the Advocate General's Opinion was that OEMs cannot justify disabling the EGR valve by claiming this is required to protect the engine. Based on this advice, this practice can be considered as using a defeat device[52]. However, such legal procedures to clarify relevant aspects of the legislation require time, e.g. 5 years after the Dieselgate scandal for the official advice of the Advocate General in the case of the EGR-valve manipulation. This illustrates the need for clear and unambiguous legislation.

4. Recommendations for a coherent, fair and future-proof post-euro 6 legislation

POLIS hereby presents its main recommendations as a constructive contribution to improved future legislation.

4.1 Policies which put the well-being of citizens first

The emission standards are in practice based on **'best available techniques'**. This limits the **ambition level** of the legislation:

- It limits the stimulation of **new and clean technology** which might initially be more expensive, not allowing it to break through
- It results in **very technical provisions** while the focus should be on protecting the health of people and the environment
- It gives way to the **development of standards and procedures** which, instead of guaranteeing low emissions, rather test the performance of specific technologies

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48 Cases T-339/16, T-352/16, T391/16 https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-12/cp180198en.pdf

49 https://ec.europa.eu/transparency/regdoc/rep/1/2019/EN/COM-2019-208-F1-EN-MAIN-PART-1.PDF

50 Case C-693/18: https://curia.europa.eu/jcms/upload/docs/application/pdf/2020-04/cp200052en.pdf

51 Required to reduce the NO_X emissions

52 https://curia.europa.eu/jcms/upload/docs/application/pdf/2020-04/cp200052en.pdf

A new framework should **put health and environment at its core**. Rather than aiming for a robust and closed structure with detailed technical provisions, there is a need for better collaboration, more transparency and more flexibility which is required for the effective protection of human and environmental health. In this framework, when irregularities are detected, **the burden of proof should lie with the OEM**.

"There is a need for better collaboration, more transparency and more flexibility which is required for the effective protection of human and environmental health"

With a stronger focus on **unambiguous principles to protect the environment**, the new framework should become **less complex**. Harmonization between LD (without taking light commercial vehicles separately) and HD vehicle legislation and a technology-neutral approach in formulating requirements will further reduce complexity. These requirements should not overlook relevant emissions such as NH_3, N_2O, VOC, CH_4, Aldehydes, etc. There is a need for **harmonisation** with other actions and legislation at the EU level. There is now an opportunity to align the new emission standards with the revision of *TEN-T Guidelines*[53], the *Alternative Fuel Infrastructure Directive*[54], and the *White Paper* and *Urban Mobility Package* (currently under revision).

4.2 Improved testing and surveillance

As long as testing procedures and conditions are extensively laid down in **complex technical and detailed fixed requirements**, we risk OEMs optimizing to those parameters. This results in unwanted behaviour of bringing vehicles to the market designed to merely pass the type-approval test, rather than to strive for minimal emissions while the vehicle is in use.

"The new emission standards require simply formulated, unambiguous, measurable environmental requirements which should apply in all driving conditions"

The new emission standards require simply formulated, unambiguous, measurable environmental requirements[55] which should apply in all driving conditions. Simple but expertly executed tests performed by independent testing parties, market surveillance authorities or during PTI should provide conclusive evidence to show an emission problem, in which case the OEM must propose and implement an effective solution swiftly.

Type-approval testing should be more than prototype demonstration, which remains useful to intercept faulty technologies before they hit the

[53] https://ec.europa.eu/transport/themes/infrastructure/ten-t_en
[54] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0094
[55] When setting such emission limits, note that The current metrics of g/km and g/kWh which excludes, e.g., the control of idling emissions must be revised. Include all types of emissions, and not only from the engine (tyre, brake, evaporative emissions)

market. However, rather than proving a specific technology has been implemented correctly, the testing framework should evolve to create **a reliable system of simple and effective in-use surveillance testing** by independent, credible parties, market surveillance authorities and PTI centres. To allow such tests, transparency is required. Vehicles should reliably indicate when they require maintenance, which should be the only valid reason to exclude them as test subjects for any kind of in-use testing. In that case, those vehicles must be fixed immediately.

Auxiliary Emission Strategies (AES) must be made public and in case they were granted unjustly, appeal should be possible. The OBD should notify the activation of an AES to assist independent parties that carry out an emissions test.

Moving away from the fragmented landscape of national TAA's and centralising these competencies and powers into **a single European type-approval agency** to grant single market access would offer better guarantees in terms of environmental performance. It would also facilitate harmonious and uniform call backs and decisive action EU-wide in case emission issues are found. The call for such a central European authority dates back to the conclusions of the EMIS committee in the wake of the Diesel gate scandal.

4.3 Clear and proper responsibilities

The aim of the legislation should be to **guarantee the lowest possible emissions over the course of the actual lifespan of the vehicles** concerned. Therefore, the concept of the 'useful lifespan', which limits the OEM's liability and all testing conditions in relation to vehicle age and mileage should be lifted. A good emission performance is a **shared responsibility** from the OEM and the owner. However, the OEMs should take a central role, given their expertise and the increasing means of monitoring the performance of vehicle (emission control) systems. They should develop and provide tools to owners and governments which allow to **reliably detect tampering or maintenance issues**. When such tools point out an emission problem, the responsibility can shift to the owner, in all other cases of emission issues, the OEM should stay responsible.

"The legislation should guarantee the lowest possible emissions over the course of the actual lifespan of the vehicles"

True on-board monitoring systems should be required, with a guarantee for transparency but also protection from tampering. Reliable data collected by on-board monitoring systems could be used during

independent testing or could be used to check for fleet emissions and check for specific goals (e.g. CO_2 fleet norms).

4.4 Enacting change for better quality of life in cities and regions

The introduction of more stringent vehicle emission standards should go hand-in-hand with the **rapid development of alternative fuels charging infrastructure** and **decreasing total cost of ownership** for the vehicles and HDVs in particular. The EC should guarantee a detailed market monitoring (offer, demand and TCO evolution) in the framework of the implementation of the revised Clean Vehicle Directive.

"The new vehicle emission standards should go hand-in-hand with the rapid development of alternative fuels charging infrastructure and decreasing TCO"

The cities' efforts in the introduction of the **LEZs and ZEZs** should be recognised and further encouraged. The technology neutrality approach for light-duty vehicles (LDVs) in the cities should be replaced by **zero-tailpipe emission vehicles**. For the heavier duty vehicles, electric modes within the urban areas should be considered and encouraged.

5. Abbreviations list

ACEA	European Automobile Manufacturers Association
AES	Auxiliary emission strategies
BEV	Battery Electric Vehicle
CF	Conformity Factor
DPF	Diesel Particle Filter
DG-ENV	Directorate-General for Environment (EC)
DG-GROW	Directorate-General for Internal Market, Industry, Entrepreneurship and SEMs (EC)
DG-MOVE	Directorate-General Mobility and Transport (EC)
EC	European Commission
EEA	European Environmental Agency
EGR	Exhaust Gas Recirculation
EMIS	European Parliament Committee of Inquiry into Emission Measurement in the Automotive Sector
ERTRAC	European Road Transport Research Advisory
GDP	Gross Domestic Product
GHG	Green House Gases
GTTA	Granting Grant Type Approval Authority
HDV	Heavy Duty Vehicle
ICCT	International Council on Clean Transportation
ICEV	Internal Combustion Engine Vehicle
ISC	In-Service Conformity
LDV	Light Duty Vehicle
LEZ	Low Emission Zone
LNT	Lean NO_x traps
MS	Member State
NEDC	New European Driving Cycle
OBD	On-board diagnosis
OEM	Original Equipment Manufacturer
PEMS	Portable Emissions Measurement System
PHEV	Plug-in Hybrid Vehicle
PTI	Periodic Technical Inspection
RDE	Real Driving Emissions
SRC	Selective Catalytic Reduction System
SUMP	Sustainable Urban Mobility Plan
TA	Type Approval
TAA	Type Approval Authority
UVAR	Urban Vehicles Access Regulations
WHO	World Health Organisation
WLTP	Worldwide Harmonised Light Vehicle Test Procedure
ZEZ	Zero Emission Zone