Council of the European Union

Brussels, 10 November 2022
(OR. en)

14598/22
ADD 4

Interinstitutional File:
2022/0365(COD)

MI 805
ENV 1137
ENT 155
CODEC 1709
IA 181

COVER NOTE

From:	Secretary-General of the European Commission, signed by Ms Martine DEPREZ, Director
date of receipt:	10 November 2022
To:	Ms Thérèse BLANCHET, Secretary-General of the Council of the European Union
No. Cion doc.:	SWD(2022) 359 final (1/3)
Subject:	COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Accompanying the document PROPOSAL FOR A REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on type-approval of motor vehicles and of engines and of systems, components and separate technical units intended for such vehicles, with respect to their emissions and battery durability (Euro 7) and repealing Regulations (EC) No 715/2007 and (EC) No 595/2009

Delegations will find attached document SWD(2022) 359 final (1/3).

Encl.: SWD(2022) 359 final (1/3)

EUROPEAN
COMMISSION

Brussels, 10.11.2022
SWD(2022) 359 final

PART 1/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

PROPOSAL FOR A REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on type-approval of motor vehicles and of engines and of systems, components and separate technical units intended for such vehicles, with respect to their emissions and battery durability (Euro 7) and repealing Regulations (EC) No 715/2007 and (EC) No 595/2009

{COM(2022) 586 final} - {SEC(2022) 397 final} - {SWD(2022) 358 final} - {SWD(2022) 360 final}

Contents

Glossary

Acronym	Meaning
AGVES	Advisory Group on Vehicle Emission Standards
AAQD	Ambient Air Quality Directive
ASC	Ammonia Slip Catalyst
BEV	Battery Electric Vehicle
CEM	Continuous Emission Monitoring
CI	Compression Ignition engine vehicles (diesel vehicles)
CNG	Compressed Natural Gas
CoP	Conformity of Production
HDV	Heavy-Duty Vehicles (lorries and buses)
DPF	Diesel Particulate Filter
EATS	Exhaust Aftertreatment System
EHC	Electrically Heated Catalyst
EGR	Exhaust Gas Recirculation
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPF	Gasoline Particulate Filter
ICE	Internal Combustion Engine
ISC	In-Service Conformity
LDV	Light-Duty Vehicles (cars and vans)
LPG	Liquefied Petroleum Gas
MaS	Market Surveillance
NAO	Non Asbestos Organic (brake pads)
NECD	National Emission reduction Commitments Directive
NPV	Net Present Value
OBD	On-Board Diagnostics
OBFCM	On-Board Fuel Consumption Meters
OTA	Over-The-Air (data transmission)
PEMS	Portable Emission Measurement Systems
PFI	Port Fuel Injection
PHEV	Plug-in Hybrid Electric Vehicle
PI	Positive Ignition engine vehicles (petrol and gas vehicles)

PTI	Periodic Technical Inspections
RDE	Real Driving Emissions
RSI	Roadside Inspections
SCR	Selective Catalytic Reduction
TWC	Three-Way Catalytic converter
UNECE	United Nations Economic Commission for Europe
WHO	World Health Organization
WHSC	Worldwide Harmonised Steady State Driving Cycle
WHTC	Worldwide Harmonised Transient Driving Cycle
WLTP	World Harmonised Light Vehicle Test Procedure

Glossary emission species

Formulae	Meaning
CH_2O / HCHO	Formaldehyde
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HC	Hydrocarbon (Total hydrocarbons (THC) and Non-methane hydrocarbons (NMHC))
NH_3	Ammonia
NMOG	Non-methane organic gases
NMVOC	Non-methane volatile organic compounds
N_2O	Nitrous oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxide (Nitrogen dioxide (NO_2) and Nitric oxide (NO))
O_3	Ozone
PM	Particulate matter
PM_{10}	Particulate matter with an aerodynamic diameter smaller than 10 micrometres (<10 µm)
$PM_{2,5}$	Particulate matter with an aerodynamic diameter smaller than 2.5 micrometres (<2,5 µm)
PN	Particle number

1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT

1.1 Political context

Air pollution remains the single largest environmental and health risk in Europe.[1] While air quality has improved, a significant proportion of the EU's urban population is still exposed to pollutant concentrations above the limits defined by the Ambient Air Quality Directive[2]. Even greater proportion faces the pollution concentrations above the maximum levels recommended by the World Health Organization (WHO)[3], while even low level of pollution was recently shown[4] to be associated with increased mortality due to cardiovascular, respiratory and lung cancer. Road transport is still a major contributor to air pollution, while other sectors like residential heating, industry, energy supply or agriculture are also important source of harmful emissions. It is estimated that road transport caused about 70 000 premature deaths in the EU-28 in 2018.[5] It was on average responsible for 39% of the harmful NO_x emissions in 2018 (47% of the NO_x emissions in urban areas[6]), and 11% of total PM_{10} emissions in 2018[7]. The Dieselgate scandal[8] unveiled the widespread use of illegal defeat devices[9] in diesel vehicles, leading to abnormally high emissions on the road, compared to emissions tested in the laboratory. While the Commission has since introduced real driving emissions testing and modernised type approval procedures, the European Parliament Committee of Inquiry into Emissions Measurements in the automotive sector recommended that the Commission also proposes new technology-neutral Euro 7 emissions limits.[10]

The European Green Deal[11] (EGD) is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy. The EU should also promote and invest in the necessary digital transformation and tools as these are essential enablers of the changes. In order to reach climate neutrality by 2050 and zero-pollution ambition for a toxic-free environment, all sectors need to transform, including the road transport. EGD foresees adoption of a proposal for more stringent air pollutant emissions standards for combustion-engine vehicles (Euro 7).

---

[1] EEA, 2020. Air quality in Europe – 2020 report

[2] Directive 2008/50/EC on ambient air quality and cleaner air for Europe

[3] EEA, 2020. Exceedance of air quality standards in Europe

[4] Brunekreef, B. et al, 2021. Mortality and Morbidity Effects of Long-Term Exposure to Low-Level PM2.5, BC, NO2, and O3: An Analysis of European Cohorts in the ELAPSE Project

[5] See footnote 1 (EEA air quality report). This estimate is based on estimated 379 000, 54 000 and 19 400 premature deaths in the EU-28 in 2018 from fine particles pollution, NO_2 and O_3 emissions in the ambient air, respectively, and the estimated share of road transport in 2018 of 39% of the harmful NO_x emissions and of 11% of total PM_{10} emissions.

[6] JRC, 2019. Urban NO_2 Atlas

[7] EEA, 2020. Air pollutant emissions data viewer (Gothenburg Protocol, LRTAP Convention) 1990-2018

[8] The car emission scandal was set off by the revelation by the US Environmental Protection Agency (EPA) in September 2015 that the Volkswagen Group had used defeat devices in 500 000 diesel cars in the United States to comply with pollutant emission limits in laboratory conditions. Shortly after, it was confirmed by the German authorities that Volkswagen had also used defeat devices in approximately 8.5 million cars in Europe for model years 2009-2015.

[9] Defeat Devices are elements of car design that diminish the emission controls under certain circumstances. They are mostly prohibited, unless there is a specific and well justified reason for their use.

[10] EMIS, 2017. European Parliament recommendation of 4 April 2017 to the Council and the Commission following the inquiry into emission measurements in the automotive sector

[11] COM(2019) 640 final. The European Green Deal

To accelerate decarbonisation of the road transport, the Commission proposed in July 2021 legislation on CO_2 emission performance standards for cars/vans[12], to ensure a clear pathway towards zero-emission mobility.[13] Moreover, the Commission adopted in December 2020 the Sustainable and Smart Mobility Strategy[14] and in May 2021 the Zero-Pollution Action Plan[15]. According to those strategies, transport should become drastically less polluting, especially in cities and Euro 7 is considered as a vital part of the transition towards clean mobility.

Last but not least, the New Industrial Strategy for Europe[16] offers tools to address the twin challenge of the green and the digital transformation and to support the European industry in making the EGD ambition a reality. New pollutant emission framework will offer legal certainty and first-mover advantage to the EU automotive sector, avoiding the risk of falling behind other major jurisdictions setting new pollutant emission standards.

Transition towards only zero-emission vehicles fleet will however be spread across at least two decades, not least given the average lifetime of vehicles of more than 11 years. Meanwhile, in order to achieve the above policy objectives, it is imperative to ensure that the internal combustion-engine vehicles which will continue to be placed on the market are as clean as possible. This is a prerequisite for protection of human health, in particular in urban areas[17].

1.2 Legal context

Emission standards for light-duty vehicles (cars/vans), and heavy-duty vehicles (lorries/buses), were implemented in the EU since 1992 through a series of Euro emission rules which addressed one of the major sources of air quality problems, i.e. tailpipe pollutants emitted to the air. These standards are embedded in the general type-approval framework[18], based on which new vehicle models are tested, granted type-approval and verified against a minimum set of safety and emission requirements before entering into service on the EU market. Over the years, with successive Euro standards, not only the specific limits for pollutants were tightened, but also the pollutant testing procedures were gradually modernised. The current emission standards were adopted in 2007 for light-duty vehicles (LDVs-Euro 6) and in 2009 for heavy-duty vehicles (HDVs-Euro VI).[19][20] They entered into force in 2014 for LDVs and in 2013 for HDVs.[21]

---

[12] COM(2021) 556 final. Proposal for a Regulation amending Regulation (EU) 2019/631 as regards strengthening the CO_2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition

[13] In 2022, this will be followed by a proposal on CO_2 emission performance standards for heavy-duty vehicles.

[14] COM(2020) 789 final. Sustainable and Smart Mobility Strategy – putting European transport on track for the future

[15] COM(2021) 400 final. Pathway to a Healthy Planet for All EU Action Plan: Towards Zero Pollution for Air, Water and Soil

[16] COM(2020) 102 final, A New Industrial Strategy for Europe, COM(2021) 350 final, Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery

[17] Urban areas are characterised by high volume of traffic emitting air pollutants and high population density. The population in urban areas is therefore exposed to higher concentrations of air pollutants than in rural areas and more citizens are effected.

[18] Regulation (EU) 2018/858 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles

[19] Regulation (EC) No 715/2007 on type-approval of motor vehicles with respect to emissions from light

The testing procedures have been adjusted by implementing Regulations over the different steps of Euro 6b-d and Euro VI A-E between 2013 and 2022 (see Annex 5, Table 36 for details)[22]. The introduction of Real Driving Emissions (RDE) testing in 2017 (footnote 24 below) required testing of pollutants in real-driving and no more only in laboratory conditions, bringing about significant reduction of harmful emissions[23]. In 2019 also more stringent verification by in-service conformity procedure (ISC), ensuring that vehicles meet the emission limits during their service, was introduced.[24]

The Euro emission standards include references to testing procedures set out in UN regulations[25]. The UN World Forum for Harmonization of Vehicle Regulations focusses on the establishment of global harmonisation of technical regulations for vehicles. The EU as a contracting party, has ensured that all relevant UN Regulations are aligned with the Euro 6/VI emission limits and testing procedures.

1.3 Interaction between Euro emission standards and other EU air pollutant policies

As shown in Figure 1, Euro emission standards for vehicles are interlinked with several other EU rules which tackle air pollutants of the road transport as well as with the CO_2 emission standards[26] which reduce air pollutants as a co-benefit.

passenger and commercial vehicles (Euro 5 and Euro 6) and its implementing Regulation (EU) 2017/1151; Regulation (EC) No 595/2009 on type-approval of motor vehicles and engines with respect to emissions from heavy-duty vehicles (Euro VI) and its implementing Regulation (EU) No 582/2011

[20] SEC(2005) 1745 Commission Staff Working Document, Impact Assessment on Euro 5/6 emission standards; SEC(2007) 1718 Commission Staff Working Document, Impact Assessment on Euro VI emission standards; together referred to as Euro 6/VI impact assessments in the following

[21] In 2014 for light-duty vehicles and 2013 for heavy-duty vehicles, air pollutant emission limits entered into force for NO_x (nitrogen oxide), PM (particulate matter), PN (particle number), CO (carbon monoxide), THC (total hydrocarbons) and NMHC (non-methane hydrocarbons) and, for heavy-duty vehicles only, CH_4 (methane) and NH_3 (ammonia). (See Annex 5, Table 35 for details)

[22] They also include trailers used in heavy duty vehicles for what concerns their effect on CO_2 emissions.

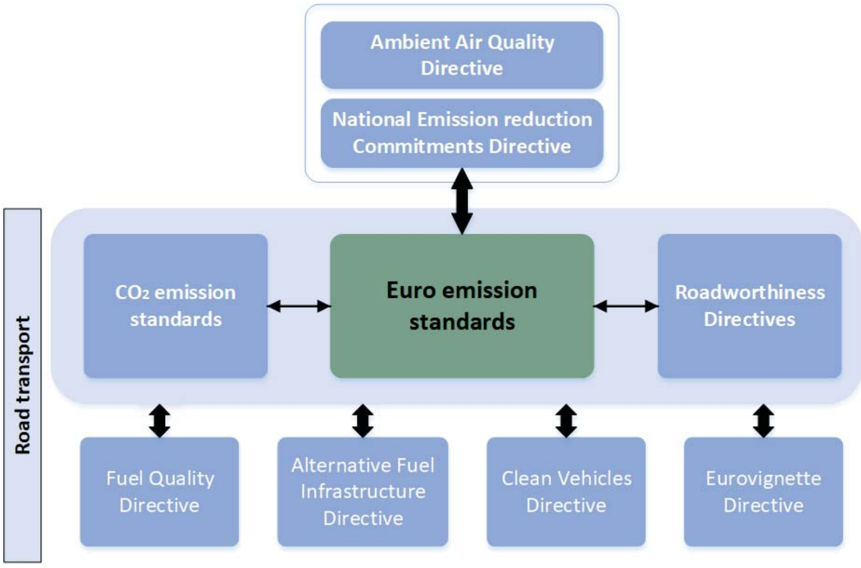
[23] Regulation (EU) 2017/1151, supplementing Regulation (EC) No 715/2007 on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6)

[24] Regulation (EU) 2018/1832 for the purpose of improving the emission type approval tests and procedures for light passenger and commercial vehicles, including those for in-service conformity and real-driving emissions and introducing devices for monitoring the consumption of fuel and electric energy

[25] Regulation No 83 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of vehicles with regard to the emission of pollutants according to engine fuel requirements; Regulation No 49 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines and positive ignition engines for use in vehicles

[26] Regulation (EU) 2019/631 CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, Regulation (EU) 2019/1242 CO_2 emission performance standards for new heavy-duty vehicles

Figure 1- EU rules tackling air pollutants in the road transport sector



- The scale of policy actions undertaken in Europe to specifically address transport-related air pollution has increased over recent years, reflecting the important contribution of transport to air pollution, in particular in urban areas. Local and regional air quality management plans — including initiatives such as low- or zero-emission zones in cities and congestion charges — are now used in many areas where the level of air pollution from transport is high. The Ambient Air Quality Directive (AAQD)[27] aims at improving air quality by setting limits for the ambient air concentrations of specific air pollutants from all air pollution sources (e.g. agriculture, energy, manufacturing, etc.). The National Emission reduction Commitments Directive (NECD) aims at reducing national air pollutant emissions by setting national reduction commitments for five specific air pollutants[28], with reductions from all sectors, including road transport. The current AAQD/NECD cover ambient levels of air pollutants and emissions of road transport and the Euro emission standards for vehicles help Member States meeting their NECD reduction commitments.

  As part of the European Green Deal, the Commission announced that it will revise in 2022 EU rules on air quality proposing to strengthen provisions on monitoring, modelling and air quality plans and revising the air quality legislation to align them more closely with the new WHO recommendations[29]. It is clear from the analysis[30] carried out by one of the most authoritative air quality modelling group in Europe, i.e.

---

[27] Directive 2008/50/EC on ambient air quality and cleaner air for Europe

[28] Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants. The Directive establishes the emission reduction commitments for the Member States' anthropogenic atmospheric emissions of SO_2, NO_x, NMVOC, NH_3 and $PM_{2,5}$ and requires that national air pollution control programmes be drawn up, adopted and implemented and that emissions of those pollutants and the other pollutants referred to in Annex I, including CO, as well as their impacts, be monitored and reported.

[29] World Health Organization, 2021. WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide.

[30] European Commission, 2022. Revision of the Ambient Air Quality Directives

the International Institute for Applied Systems Analysis (IIASA), that full compliance will not be achieved without extra measures. In 2030 more than 52 million EU citizens will continue to be exposed to NOx concentrations higher than the WHO recommended air quality concentration levels due to road traffic. This analysis relied on incorporating the assumptions under the Option 3a of this Impact Assessment. This demonstrates the importance of limiting emissions at the source, by setting stricter emissions standards (such as the Euro ones for road transport) and requirements for improved fuel quality. The introduction of stricter Euro emission standards for all air pollutant emissions from road transport is needed in order for Member States to achieve compliance with new targets on air quality, while limiting the need to impose vehicle circulation bans. The interactions are further explored in the next sections.

- The CO_2 emission standards support the EU's climate ambition set in European Climate Law[31], which aims at reducing EU greenhouse gas emissions by at least 55% by 2030, compared to 1990. Since the CO_2 emission standards have proven to be an effective policy tool in this respect[32], the Commission revised and strengthened the CO_2 emission standards for cars/vans in July 2021 (see 1.1). Significant positive effects on air quality can be expected from the amendment of the CO_2 standards, setting an end-date of 2035 for placing new combustion-engine cars and vans in the EU market. The revision of the CO_2 emission standards for heavy-duty vehicles is foreseen by end-2022, aiming at increasing uptake of zero- and low emission heavy-duty vehicles and enhanced fuel efficiency of conventional engines.

- The Roadworthiness Directives[33] have the objective to increase road safety in the EU and to ensure the environmental performance of vehicles, by means of regularly testing vehicles throughout their operational lifetime. As far as emissions are concerned they have as objective to contribute to the reduction of air pollutant emissions by detecting more effectively vehicles that are over-emitting due to technical defects, through periodic technical inspections (PTI) and the roadside inspections (RSI). The Euro emission standards and Roadworthiness Directives should operate in a complementary way with the aim to reduce air pollutant emissions from road vehicles.

- The Fuel Quality Directive[34] sets obligation of reduction of air pollutants from liquid transport fuels, the Eurovignette Directive[35] sets common rules on road infrastructure charges and the Clean Vehicles Directive[36] promotes clean mobility solutions through public procurement. While the Euro emission standards require clean performance of

[31] Regulation 2021/119 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')
[32] SWD(2021) 613 final, Commission Staff Working Document, Impact Assessment, Accompanying the document Proposal for a Regulation amending Regulation (EU) 2019/631 as regards strengthening the CO_2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition
[33] Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers; Directive 2014/47/EU on the technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Union
[34] Directive 2009/30/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions
[35] COM(2017) 275 final, Proposal for a Directive amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures
[36] Directive 2019/1161/EU on the promotion of clean and energy-efficient road transport vehicles

vehicles, the Alternative Fuel Infrastructure Directive (AFID)[37] promotes the use of alternative fuels for road transport. The Eurovignette Directive and Clean Vehicles Directive may support the demand for clean vehicles by allowing Member States to vary road charges based on pollutant emissions of vehicles and by setting requirements for higher share of clean vehicles in public procurement.

2 PROBLEM DEFINITION

2.1 What are the problems?

The negative impact of road transport to air pollution has only marginally decreased over the recent years. This relative stagnation is mainly due to the ever-growing vehicle fleet[38] and increase in transport demand compared to more significant emission reductions in other sectors[39]. Also, despite improvements in the emission regulation, gaseous pollutants, in particular NO_x and exhaust particles are still emitted through tailpipes of ICE vehicles while non-exhaust particles are a result of brake and tyre wear produced by all vehicles, including zero-emission vehicles. This leads to more than 70% of ultrafine particles[40] in EU cities being attributed to road transport, either directly (primary emissions) or indirectly (secondary aerosol).[41] Furthermore, preliminary analysis done for the revision of EU air quality legislation[30] carried out by one of the most authoritative air quality modelling group in Europe, i.e. the International Institute for Applied Systems Analysis (IIASA), has shown that full compliance with NO_2 limits cannot be reached with today's vehicle emission standards.

Since the entry into force of Euro 6/VI emission limits until 2020, NO_x vehicle emissions on EU roads have decreased by 22% for cars/vans and by 36% for lorries/buses.[42] In addition, exhaust PM emissions from cars/vans have decreased by 28%, and by 14% from lorries and vans. THC emissions from lorries/buses went down by 14%, while THC and NMHC emissions from cars/vans went down by 13 and 12%.[42] Further emission reductions are expected to be made as more Euro 6d and Euro VI E vehicles enter the market[43].

In the same Euro 6/VI period, health impacts and the related external costs of medical treatment and production losses due to illness and death were reduced by €97 billion EU-wide due to reduced NO_x and PM emissions from road transport.[44] However, pollutant emissions caused by road transport still affect hundreds of thousands of European citizens and lead to significant health impacts and related external costs each year. In 2018 an EPHA study[45] estimated that any inhabitant of European cities suffered an

[37] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure
[38] ACEA, 2021. Vehicles in use Europe
[39] CLOVE, 2022. Euro 6/VI Evaluation Study. ISBN 978-92-76-56398-, chapter 5.1.5.3 What has been the contribution of the standards to achieving National Emission Ceilings Directive (NECD) targets?
[40] Ultrafine particles are defined here as those having less than 0.1 µm of diameter.
[41] CORDIS, 2019. Ultrafine particles and health impact: revising EU policy
[42] CLOVE, 2022. Euro 6/VI Evaluation Study. ISBN 978-92-76-56398-3. Chapter 5.1.2.4 What was the impact of Euro 6/VI on the total level of emissions?
[43] The late introduction of RDE testing in the final Euro 6d step contributed to delayed progress in pollutant emission reduction under Euro 6, which will materialise only after 2020 (see Figure 20 in Annex 5).
[44] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.1 Effectiveness, Evaluation question 3
[45] EPHA, 2020. Health costs of air pollution in European cities and the linkage with transport

average welfare loss of over €1 250/year due to direct and indirect health impacts of poor air quality, which is equivalent to 3.9% of income earned in cities. While these air quality problems are not exclusively caused by road transport, the same study demonstrated that a 1% increase in the number of cars in a city is expected to lead to an overall increase in health costs by almost 0.5%.

NO_x and particles (expressed as $PM_{2.5}$) are the key air pollutants from road transport. In Figure 2, the evolution of NO_x and total (i.e. exhaust and non-exhaust) $PM_{2.5}$ emission between 2010 and 2040 is shown first for cars/vans and then for lorries/buses[46]. The fit-for-55 package of 14 July 2021, i.e. the adopted CO_2 emission standards proposing an end-date of 2035 for placing new combustion-engine cars and vans on the EU market as well as the projected fit-for-55 HDV fleet evolution to contribute to the 55% net greenhouse gas emission reduction by 2030 and the 2050 climate neutrality objective, have been factored in. The fit-for-55 package results in an expected increase of zero-emission vehicles in the vehicle fleet and, as Figure 2 shows, a decrease in both NO_x and exhaust $PM_{2.5}$ emissions. Following the proposed end-date of 2035, the emissions of NO_x and exhaust particles from cars/vans are expected to decline more steeply than those from lorries/buses. Still, combustion-engine cars and vans will continue to be part of the European fleet after 2035. In 2040, 49% of European fleet of cars and vans is still expected to consist of combustion-engine vehicles, including hybrids[47].

Moreover, increasing penetration of the latest Euro 6d/VI E vehicles in the fleet results in NO_x and exhaust $PM_{2.5}$ reduction (see Figure 2). However, Figure 2 also shows that there is no reduction of non-exhaust $PM_{2.5}$ emissions from brake and tyre wear for neither cars/vans or lorries/buses, given lack of emission control technologies in place. Controlling such non-exhaust emissions is needed, not least because they are also emitted from zero-emission vehicles. The difference between total and exhaust $PM_{2.5}$ will increase in the future for all vehicles. The projections to 2040 show that the zero-pollution ambition for a toxic-free environment, as set out in the European Green Deal, cannot be reached in the road transport sector in the near future with the current legislation in place. To improve our health and well-being in line with the Zero-Pollution Action Plan[15], air pollutants emission needs to be reduced towards zero-pollution as rapidly as possible.

The NO_x and exhaust $PM_{2.5}$ emission limits are of particular concern given that they were set as early as 2007 for cars/vans, and 2009 for lorries/buses (and assessed more than two decades ago). Furthermore, approximately 20% of current real-driving mileages in Europe are estimated to be outside the RDE testing boundaries and therefore may exceed significantly the current emission limits[63]. Significant technical evidence on this issue was gathered by major research projects, including those of the Joint Research Center (JRC), GreenNCAP and AECC[48],[49],[50],[51],[52],[53]. The test data were collected in a database

[46] The proposed end-date of 2035 for new combustion-engine cars/vans, projected fit-for-55 HDV fleet evolution and fleet renewal with Euro 6/VI vehicles is taken into account. Additional effects from the planned revision of the Ambient Air Quality Directives in 2022, which are estimated limited compared to the effects of CO_2 emission standards, cannot be taken into account yet.

[47] SIBYL, 2021: Ready to go vehicle fleet, activity, emissions and energy consumption projections for the EU 28 member states

[48] CLOVE, 2022. Technical studies for the development of Euro 7. Testing, Pollutants and Emission Limits. ISBN 978-92-76-56406-5.

[49] Data provided by GreenNCAP (https://www.greenncap.com/)

[50] Real-world emission data measured on-road and on chassis-dyno of Light- and Heavy-duty demonstrator

run by the JRC[54]. Analysis of the data proves that when driven outside RDE testing boundaries, vehicles still emit significantly higher than when driven within RDE testing boundaries. As an example, the average of NOx emissions by diesel passenger cars outside RDE boundaries[55] is 475% higher than when driven within RDE boundaries. This means that just 1 km run outside the current RDE boundaries will pollute on average the same as 475 km run inside current RDE boundaries.

In addition, there are currently no emission limits for particles emitted by brake and tyre wear. As can be seen in Annex 4, the average tailpipe emissions of particles from a passenger car is currently much less than 1 mg/km, while the average particle emissions from the brakes is estimated to be 11 mg/km, i.e. more than 11 times higher.

Moreover, there is urgent need to address pollutants emission from heavy-duty vehicles. The projected fit-for-55 share of new combustion-engine heavy-duty vehicles including hybrids, placed on the EU market is expected to be 53% in 2040 (see Figure 7 in section 5.1), while the overall share of combustion-engine heavy-duty vehicles in the EU fleet would still be 86%[47]. At the same time, the NO_x and exhaust $PM_{2.5}$ emission limits for these vehicles were set in 2009, on the basis of engine testing only. Emission limits should be set on the basis of the emissions of the entire heavy-duty vehicle, as it is the case for light-duty vehicles.

Conclusion: Despite proposed end-date of 2035 for placing new combustion-engine cars and vans on the EU market, increasing share of zero- and low-emission heavy-duty vehicles and new Euro 6d/VI E vehicles entering the market, a zero-pollution level cannot be reached for NO_x and total $PM_{2.5}$ emissions from road transport. The main reasons are obsolete vehicle emission limits adopted over a decade ago, unaccounted real-driving emissions from cars and vans, not regulated vehicle brake emissions and the slower transition of lorries to zero-emission powertrains.

As shown in the evaluation of the Euro 6/VI emission standards, cost-effective pollutants emission reduction from road transport stems from the mandatory Euro standards introduced at EU level, which also support Member States improving their local air quality in line with current rules and in view of the proposed revision of the Ambient Air Quality Directives and meeting their emission reduction commitments under the National Emission reduction Commitments Directive.

Figure 2 – Magnitude and evolution of the problem of air pollutants related to road transport in EU-27 **split up for cars/vans (a) and lorries/buses (b)**, with end-date of 2035 for new combustion-engine cars/vans and fleet renewal with Euro 6/VI vehicles[56]

---

vehicles were provided by the Association for Emissions Control by Catalyst (AECC). The scientific publications can be accessed via https://www.aecc.eu/resources/scientific-publications/.

[51] JRC Market Surveillance report at https://publications.jrc.ec.europa.eu/repository/handle/JRC122035

[52] Scientific paper on "On-road emissions of passenger cars beyond the boundary conditions of the real-driving emissions test" in https://www.sciencedirect.com/science/article/pii/S001393511930369X

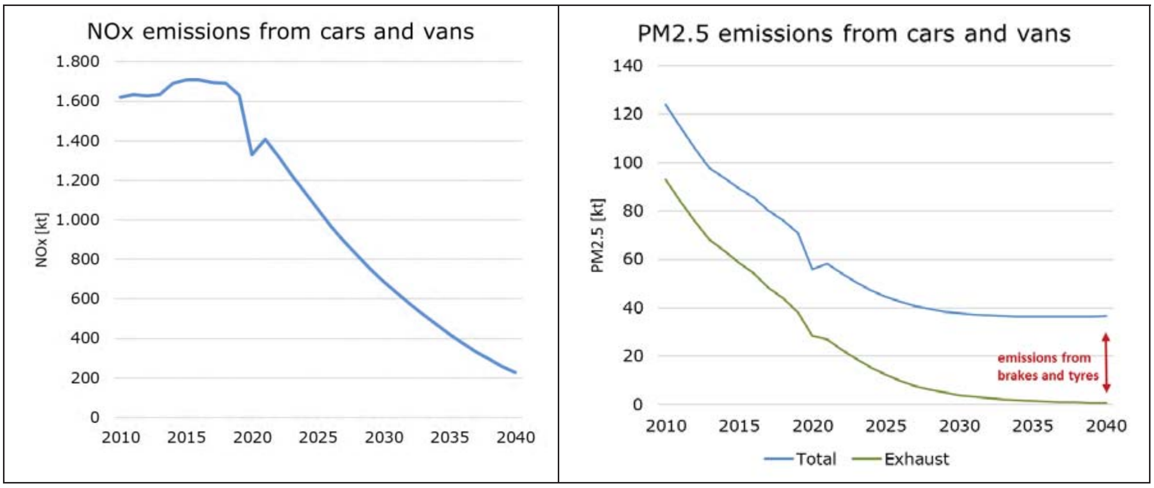
[53] Scientific papers on "Assessment of Gaseous and Particulate Emissions of a Euro 6d-Temp Diesel Vehicle Driven >1300 km Including Six Diesel Particulate Filter Regenerations", https://www.mdpi.com/2073-4433/11/6/645/htm

[54] JRC link to database when available

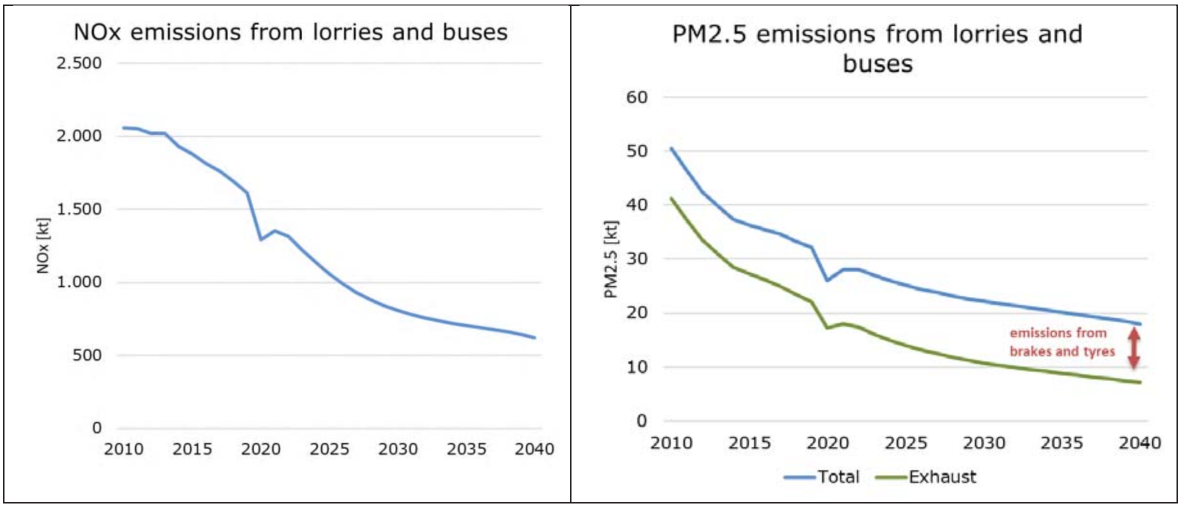
[55] Number quoted are the average of 172 tests on 54 diesel vehicles for trips outside the RDE boundaries, and 144 tests on 64 diesel vehicles for trips inside the RDE boundaries.

[56] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, Figure 4-3: Evolution of (a) NOx and (b) PM2.5 emissions from road transport after "EU fit-for-55" package. NO_x emissions are

a) Cars and vans



b) Lorries and buses



The evaluation of the Euro 6/VI emission standards identified three main problems, relevant for the cars/vans as well as the lorries/buses segment, and the related problem drivers limiting their effectiveness (see Figure 4). The problems: complexity of vehicle emission standards, obsolete vehicle pollutant limits and insufficient control of vehicle real-world emissions, explain why the current Euro 6/VI emission standards insufficiently contribute to the necessary reduction of pollutant emissions from road transport. This is of particular concern when considering the zero-pollution ambition of the European Green Deal.

Next to the negative impacts on human health and on environment, other consequences of the current Euro standards shortcomings have been identified. Firstly, the emergence of national and local measures aiming at addressing significant pollutant emissions from road transport. City or driving bans of vehicles with internal combustion engine put at risk the functioning of the single market[57] and could result in undermining consumer confidence in the automotive products.[58] Several Member States[59] request an end date for

harmful nitrogen oxide emissions (nitrogen dioxide (NO_2) and nitric oxide (NO)). $PM_{2.5}$ are harmful particles with an aerodynamic diameter smaller than 2.5 micrometres.

[57] More information on internal market can be found in 6.1.1.3 Single market.

[58] More information on consumer trust can be found in 6.1.3.4 Consumer trust.

[59] Austria, Belgium, Denmark, France, Greece, Ireland, Lithuania, Luxembourg, Malta, Netherlands, Spain,

the sales/registration of new petrol and diesel cars or announced national initiatives to ban diesel or all combustion engines or to introduce zero-emission zones[60] in order to limit health impact of air pollution and address climate change concerns. In October 2021, there are already multiple Urban Vehicle Access Restrictions (UVARs) in the EU in place or in planning: 328 Low-Emission Zone (LEZ), 130 emergency pollution schemes, 36 zero-emission zones and 6 urban tolls[61]. There is a risk that uncoordinated action at national or local level could endanger the free movement of persons and goods in the single market.

Secondly, global pressure to reduce transport emissions intensifies as key markets, in particular China and the United States, plan more demanding vehicle emission standards.

China is progressing with an ambitious China 7 emission standards[62]. The China 6b emission standards for cars/vans (applicable in 2023), are already fuel-neutral and 40 to 50% more stringent than Euro 6/VI limits.[63] The emission limits in the US (Tier 3 Bin 30) are already well below the limits for almost all Euro 6 pollutants.[64] The US currently works on proposals for more stringent emission rules to improve the US competitive position on clean and efficient cars and trucks[65,66]. Furthermore, both China and the US have increased durability requirements up to 240 000 km or 15 years. In comparison, the current European requirements reach only 100 000 km or 5 years for the complete vehicle and 160 000 km for the emission control systems. These developments are especially important when considering that in 2019 the US was next to the United Kingdom the leading destination of EU exports of vehicles, with 19% of EU-27 motor vehicles[67] being exported to US (by value). With 12% of EU-27 motor vehicle exports, China is the second most important trade partner for the EU automotive industry (see Figure 13 Annex 4).[68]

Since Brexit, the United Kingdom has become the EU's most important trade partner. In 2018, roughly one fourth of EU-27 exports was destined to the UK.[68] It is assumed that any future mutual agreement will have the ambition to continue the implementation of Euro emission standards in the UK. Switzerland, Japan and South Korea are other main destinations for exports of EU vehicles. In 2019, Switzerland was the destination of 5% of EU motor vehicle exports. Since Switzerland participates in the EU Single Market for

---

Sweden

[60] Politico, 2021. Nine EU countries demand an end date for petrol and diesel cars; Ministère de la transition écologique (FR), 2020. Développer l'automobile propre et les voitures électriques; EURACTIV, 2021. Denmark to ban petrol and diesel car sales by 2030; BBC, 2019. Ireland to ban new petrol and diesel vehicles from 2030; Reuters, 2018. Spain to propose ban on sale of petrol, diesel cars from 2040

[61] Source: https://urbanaccessregulations.eu/

[62] European Commission – JRC, 2021. Sino-EU Workshop on New Emissions Standards and Regulations for Motor Vehicles

[63] CLOVE, 2022. Technical studies for the development of Euro 7. Testing, Pollutants and Emission Limits. ISBN 978-92-76-56406-5.

[64] ICCT, 2019. Recommendations for post-Euro 6 standards for light-duty vehicles in the European Union

[65] The Wall Street Journal, 2021. Biden Administration Moves to Unwind Trump Auto-Emissions Policy

[66] The White House Briefing Room, 2021. Executive Order on Strengthening American Leadership in Clean Cars and Trucks (August 05 2021)

[67] Includes next to cars also commercial vehicles such as vans, lorries and buses. In value, the EU export of cars presented approximately 92% of the EU export of all motor vehicles. For more information, see section 1.4.1. in Annex 4.

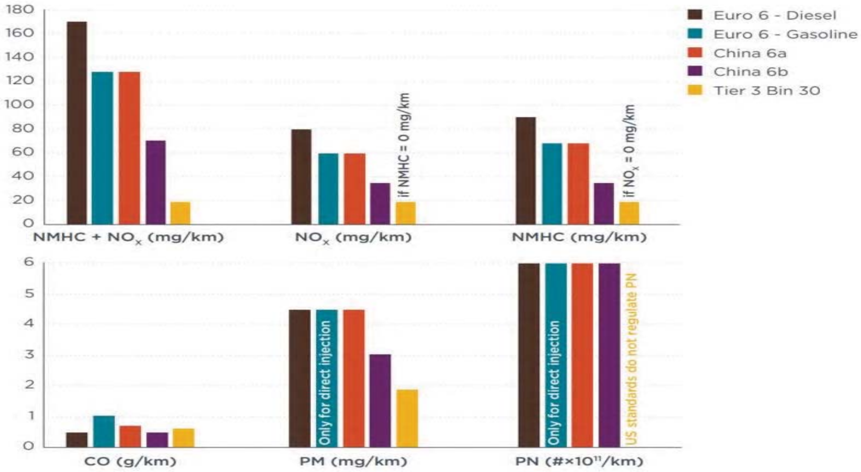
[68] ACEA, 2020. EU passenger car exports, top 10 destinations (by value); ACEA, 2020. EU motor vehicle exports, top 10 destinations (by value)

motor vehicles, Switzerland also follows the Euro emission standards. Japan, who is the destination of 5% of all EU exports of motor vehicles, employs emission control requirements for vehicles which are close to EU ones. South Korea is the destination of 4% of EU motor vehicle exports and has been following the European rules for diesel vehicle emission standards since 2002 with the Euro 6-level standard entering into force in 2020.[69]

At the same time, the EU automotive industry could maintain its competitive position on the global market of internal combustion technologies that will still play a role in several third markets for which a slower transition to zero-emission cars/vans is expected[70], such as India, South-East Asia, Brazil or South Africa, and in the lorries/buses segment, where internal combustion engines will prevail for longer. By accelerating investments in zero-emission technologies, the EU automotive value chain should not put at risk its know-how on more traditional technologies that will continue to be important for countries with slower transitions.

In conclusion, key markets for EU export of vehicles, US and China, are developing more stringent standards and other main markets are following the Euro standards. Manufacturers can adapt the manufacturing of the vehicles' emission control systems themselves to keep their export market share in key markets that are not supposed to follow the Euro emission standards, i.e. China and US. However, less regulatory entrance costs to these markets are expected with an ambitious Euro emission standards matching global developments. Without action, there is the risk that access to key markets could be hampered for EU manufacturers as it would become more costly to meet emission requirements in different markets.

Figure 3 – Comparison of latest emission limits in the EU, United States (Tier 3 Bin 30) and China for light-duty vehicles, Source: ICCT, 2019*[71]*



The problem analysis shows that there are differences in the problems and need to act between cars/vans and lorries/buses segments (see Box 1).

[69] See Annex 4, section 1.4.1. Competitiveness: Export of EU motor vehicles to key destinations
[70] See Annex 4, section 1.5.4. Cumulative impacts on industry
[71] ICCT, 2019. Recommendations for post-Euro 6 standards for light-duty vehicles in the European Union. Differences in testing procedures not taken into account.

Box 1 – Differences of the problems and need to act between cars/vans and lorries/buses segment

In 2022, electric powertrains are a widely accepted solution for urban and personal mobility with a large number of pure electric vehicle types in the market and the numbers of sales growing fast. However, for the long-haul transport of goods electrification is significantly slower with only a few pure electric models currently available.

Due to the planned phasing out of cars/vans with an internal combustion engine by 2035, and the technology-readiness of electric cars/vans, the emissions of traditional pollutants from cars/vans are expected to decline more steeply than those from lorries/buses (see Figure 2). Therefore, in the future there will be a higher contribution from lorries/buses segment to the problem of pollutant emissions from road transport and therefore a higher need to take measures to reduce pollutant emissions from this sector.

Figure 2 also shows that without action, non-exhaust particles emissions for both cars/vans and lorries/buses will not be reduced, given the lack of emission control technologies in place.

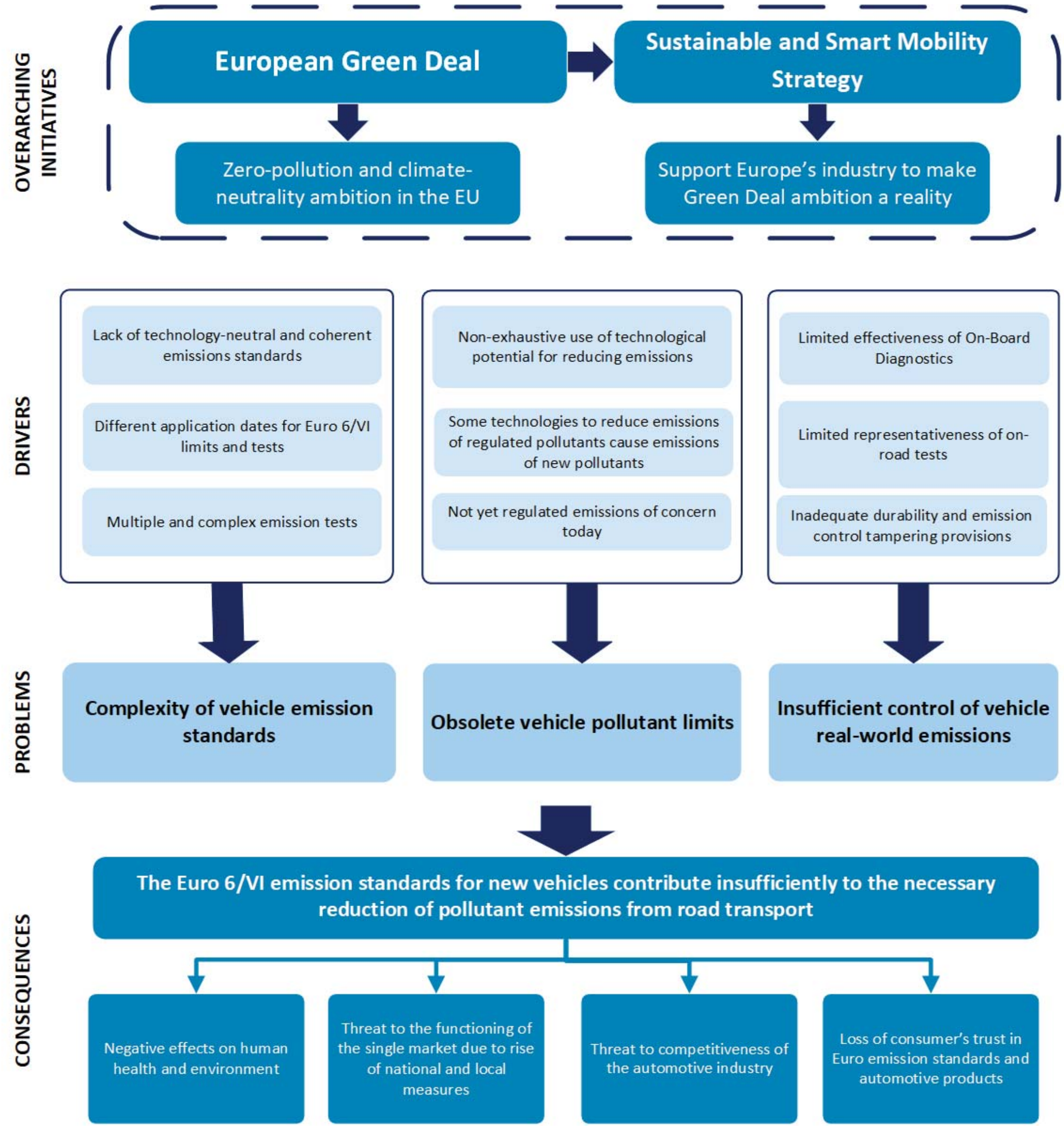
Hence there is need to act in both vehicle segments to improve our health and well-being in line with the Zero-Pollution Action Plan[15]. Moreover, the new EU Urban Mobility Framework from December 2021[72] underlines the overall importance of getting transport drastically less polluting in cities and that the majority of urban vehicle access regulations concern low (and zero) emission zones to address local air quality problems, in particular in the cars/vans segment.

The need to act towards zero-pollution needs to consider the limited time remaining to recoup the necessary investments for internal combustion engines in the cars/vans segment as well as the limited number of heavy-duty vehicles sold each year to recoup the necessary investment costs in the lorries/buses segment. For both vehicle segments, the design of policy options needs to consider options that are achievable with existing technologies and in a timely manner for introduction into vehicles by 2025.

By accelerating investments in going beyond exhaust emissions, as the Euro standards need also cover particles emissions from brakes and tyres and battery durability, the EU automotive value chain can continue to build up its competitive position in the fast growing new market of zero-emission vehicles.

[72] COM(2021) 811 final. The New EU Urban Mobility Framework

Figure 4 – Problem tree



2.1.1 Problem 1: Complexity of vehicle emission standards

The overwhelming majority of the respondents (98 of the 128) to the public consultation[73] from all stakeholder groups consider the Euro 6/VI emission standards to be complex or even very complex, for the cars/vans as well as the lorries/buses segment[74]. While some stakeholders from industry consider this complexity to be justified to ensure that vehicles are clean, the majority of stakeholders from Member

[73] See Annex 2: Stakeholder consultation, Public Consultation, Question 8

[74] Arabic numerals refer to Euro emission standards for cars and vans, Roman numerals refer to Euro emission standards for lorries and buses.

States, civil society and citizens see complexity as a factor hampering the necessary reduction of pollutant emissions from road transport.[75]

While the overall architecture of the Euro emission standards is complicated, the evaluation of the efficiency of the Euro 6/VI rules has shown that in particular shift from Euro 5/V to Euro 6/VI increased such complexity.[76] A full overview of the Euro 6/VI emission standards, including the multiple dates of introduction of different requirements, clearly demonstrates it.[77] Euro 6/VI rules were built on the legislative text of their predecessors, adding new requirements on top of the already existing ones while not always referencing the UN international harmonised testing procedures or eliminating obsolete tests. As a result, the Euro 6/VI implementing Regulations span a total of more than 1.300 pages to define properly laboratory testing and on-road testing procedures for granting type-approval, Conformity of Production and In-Service Conformity.[78]

The evaluation showed that moving from Euro 5/V to Euro 6/VI emission standards has resulted in significant increase of costs during implementation phase for vehicle manufacturers, consisting of testing and witnessing costs[79], type-approval fees[80] and administrative costs[81]. The increase of these costs was mainly caused by more robust on-road tests, however this was not accompanied by the removal of tests that became obsolete. The costs of testing of pollutant emissions and of witnessing those tests by type-approval authorities in the facilities of the manufacturers are estimated to have increased about 50% per engine family[82] for lorries/buses. Also for cars/vans, the manufacturers' effort related to the testing have doubled with the introduction of Euro 6 and quintupled with the introduction of RDE testing. The administrative costs increased up to 50%, due to the additional manufacturers' time and effort needed to meet the obligations to provide information. These costs are expected to stay rather stable over time, until new testing requirements are included.[76]

The complex matrix of Euro 6/VI rules is particularly burdensome for the type-approval authorities and technical services. Both have experienced considerable increase of costs in terms of human resources to perform additional testing and witnessing and in terms of time it takes to complete a type-approval process. [76]

[75] See Annex 2: Stakeholder consultation, Public Consultation, Question 10

[76] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.2 Efficiency, Evaluation question 4

[77] CLOVE, 2022. Technical studies for the development of Euro 7: Simplification. ISBN 978-92-76-56405-8.

[78] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 2.1 Description of Euro 6/VI emission standards and its objectives

[79] Testing and witnessing costs: Recurrent costs for testing in the context of type-approval, in-service conformity and conformity of production performed or witnessed by type-approval authorities in the facilities of the manufacturers.

[80] Type-approval fees: Recurrent costs including the fees for granting type-approval paid to type-approval authorities, excluding the witnessing costs.

[81] Administrative costs: Recurrent costs including costs for reporting and to fulfil other information provision obligations as part of the process for granting type-approval, CoP and ISC.

[82] Manufacturers are allowed to group cars/vans to model families, and lorries/buses, for which engines are tested, to engine families. All members of the family shall comply with the applicable emission limit values.

2.1.2 Problem 2: Obsolete vehicle pollutant limits

The second problem identified in the evaluation of the Euro 6/VI emission standards are obsolete vehicle pollutant limits, for the cars/vans as well as the lorries/buses segment.[83] The limits are of particular concern given that they were adopted over a decade ago (and assessed more than two decades ago). While the testing procedures for cars, vans, lorries/buses have been adjusted over the different steps of Euro 6b-d and Euro VI A-E, the emission limits were set as early as 2007 for cars/vans, and 2009 for lorries/buses.

The evaluation of the Euro 6/VI effectiveness made clear that the emission limits have achieved reductions for regulated NO_x, PM, CO, CH_4, THC and NHMC pollutants (see Table 1). However, these emission reductions would have been much higher if more pollutants than only NOx and PN were measured on the road and if state-of-the-art emission control technologies had been used.[84]

In addition, the evaluation of the Euro 6/VI has made clear that new harmful pollutants are emitted by road transport.[85] The use of new engine types, emission control systems, fuels and additives has led to worrying levels of pollutant emission not regulated by Euro 6/VI that cause significant harm to the environment and human health (ultrafine particles, N_2O, HCHO, non-exhaust brake- and tyre wear emissions and, for cars/vans, CH_4 and NH_3). Table 1 shows that much lower emission reduction for unregulated pollutants compared to regulated pollutants is observed. N_2O emissions even increased by 160% between 2010 and 2018 due to the use of catalysts.[86]

Table 1 – Pollutant emissions from road transport in 2018 compared to 2010, Source: SIBYL 2021[87]

Pollutant	Regulated under Euro 6/VI?	Air pollutant or GHG?	2010	2018	
NO_x	yes	Air pollutant	3 674 kt	3 381 kt	-8%
$PM_{2,5,total}$	no	Air pollutant	174 kt	109 kt	-37%
$PM_{2,5,exhaust}$	yes	Air pollutant	134 kt	67 kt	-50%
PN_{10}	PN_{23}	Air pollutant	$2{,}1x10^{26}$	$1{,}0x10^{26}$	-51%
CO	yes	Air pollutant	4 941 kt	3 210 kt	-35%
THC	yes	Air pollutant	795 kt	455 kt	-43%
NMHC	yes	Air pollutant	738 kt	406 kt	-45%
NH_3	HDV only	Air pollutant	75 kt	45 kt	-40%
CH_4	HDV only	GHG & air pollutant	57 kt	50 kt	-12%
N_2O	no	GHG & air pollutant	28 kt	73 kt	+160%

While many technologies to further limit the emissions of regulated or unregulated pollutants have been developed since the adoption of Euro 6/VI and are mostly available on the market, only some high-end manufacturers adopted them proactively. Even more

[83] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 6 Conclusions
[84] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.1 Effectiveness, Evaluation question 1
[85] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.3 Relevance, Evaluation question 6
[86] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7.
[87] SIBYL, 2021: Ready to go vehicle fleet, activity, emissions and energy consumption projections for the EU 28 member states

advanced technologies that allow additional emission reductions are already under development and will become available in the near future. These developments demonstrate a significant untapped past and future potential of road transport emission reductions that could have been achieved and can be achieved if such advanced emission control technologies are used.

2.1.3 Problem 3: Insufficient control of vehicle real-world emissions

It is eye-catching that a majority of stakeholders from all groups consider that real-world emissions are not adequately monitored (72 out of 124) over the lifetime of vehicles, for the cars/vans as well as the lorries/buses segment.[88] More than half of the respondents from Member States and civil society[89] are not convinced that RDE testing ensure that vehicles are compliant with the pollutant limits in "all driving conditions" (while RDE addresses only "normal conditions of use").[88] This is reinforced by the scientific assessment performed during the supporting studies which estimates the distribution of the actual driving mileages in the EU. Approximately 20% of current driving mileages in Europe are estimated to be outside the RDE legal boundaries and therefore may exceed significantly the current emission limits[63]. Driving conditions or trips that are excluded from RDE testing are usually characterized by too low (less than -7°C) or too high ambient temperatures (more than 35°C), too aggressive driving, high altitude, etc. In addition, too short (i.e. less than 15 000 km) or too long car mileage (more than 100 000 km) are also not part of RDE.

In 2017 real-world emissions of NOx were still several times above the allowed Euro 6 limit. Even though the latest Euro 6d step, adopted in the wake of Dieselgate, has endeavoured to close this gap between real-world and type-approved emissions, evidence from the evaluation of Euro 6/VI shows that this step only partially achieved it.[90] Such partial success is at least to a certain extent result of the regulatory choices made at the time of adoption of the first Real Driving Emissions Regulation[91].

Moreover, Euro 6/VI durability requirements are significantly below the actual lifetime of vehicles in the EU. While the average age of cars on EU roads is around 10.8 years, the Euro 6 emission standards take into account a lifetime of only 5 years. Similar discrepancies in the durability requirements are found for vans, lorries/buses (see Annex 5, Table 46). Since in-service conformity of vehicles and durability of their pollution control devices is checked only for the prescribed 5 years, emissions are not properly controlled over the entire lifetime of vehicles.[92]

An additional issue that was identified in the recent proposal of a Battery Regulation[93], relates to the lack of control of the durability of the propulsion batteries in plugin hybrid

[88] See Annex 2: Stakeholder consultation, Public Consultation, Question 14

[89] 7 of the 12 Member State respondents disagreed that RDE testing ensures that cars/vans are compliant with the pollutant limits in all driving conditions (10 of the 18 respondents from civil society), and 6 of the 11 Member State respondents disagreed that that lorries/buses are compliant with the pollutant limits in all driving conditions (8 of the 15 respondents from civil society).

[90] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.1 Effectiveness, Evaluation question 2

[91] In regards the scope of RDE testing boundary conditions and introduction of a conformity factor.

[92] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.3 Relevance, Evaluation question 6

[93] Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020, COM(2020) 798/3.

and battery electric vehicles. This problem may lead to lack of consumer trust in such new technologies but also higher emissions in the case of plugin hybrids, where deterioration in the battery capacity will result in higher emissions from the internal combustion engine.

2.2 What are the problem drivers?

2.2.1 Drivers behind the complexity of vehicle emission standards

- *Lack of technology-neutral and coherent emissions standards*

The Euro 6/VI emission standards lack technology-neutrality. Different combustion engine technologies, spark-ignition (petrol), compression-ignition (diesel), used in the same vehicle category – cars, vans or heavy-duty vehicles – have to comply with different emission limits. Such differences of limits stringency and implementation dates result from the intention, at the time of their setting, to provide more flexibility for diesel technology. This distinction can no longer be supported.

Such technology preference limited the effectiveness and internal coherence of the standards in reducing pollutants emissions from road transport.[94] While diesel cars are allowed to emit 80 milligrams of NO_x/km, petrol cars have to comply with a more stringent limit of 60 milligram NO_x/km. Hence, sufficient NO_x emission reduction is not achieved by diesel cars despite availability of appropriate emission control systems. Moreover, the PN limits do not apply to all petrol vehicles as the rules exclude port fuel injection (PFI) vehicles, which have an estimated share of 30% of new petrol vehicle registrations in 2020[95].

89 out of 128 stakeholders from all groups participating in the public consultation confirm that different limits based on fuel and technology are complex – with Member States being relatively more convinced of this than industry.[96]

According to Member States and civil society, separate regulatory frameworks between LDVs, and HDVs, are not coherent and contribute to complexity.[96] While the obligations for emissions testing for LDVs and HDVs set out in the implementing Regulations[97] are relatively different, the architecture of the basic acts of Euro 6 and Euro VI[98] is almost identical. This calls for a single basic act for both vehicle categories.

- *Different application dates of Euro 6/VI limits and tests*

Another driver of complexity for Euro 6/VI emission standards is the gradual phase- in of different steps of Euro 6b-d and of Euro VI A-E, in combination with different application dates for different vehicle categories and, additionally, for new types of vehicles and for all new vehicles. Different emission limits due to different technologies (see above) required different application dates and specific testing procedures, which moreover continued to be improved.

---

[94] See footnote 84; see Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.4 Coherence, Evaluation question 7
[95] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 2.1 What is/are the problem(s)?
[96] See Annex 2: Stakeholder consultation, Public Consultation, Question 9
[97] Regulation (EU) 2017/1151 and Regulation (EU) No 582/2011
[98] Regulation (EC) No 715/2007 and Regulation (EC) No 595/2009

119 out of 128 respondents to the public consultation from all stakeholder groups indicated that different application dates for Euro 6/VI steps are complex.[96] Industry indicated that it would have been better to define the steps of Euro 6 b-d and Euro VI A-E at the time of Euro 6/VI adoption, instead of continuous addition of the steps, with no sufficient lead-time to industry.[84]

- *Multiple and complex emission tests*

The procedures and, to a lesser extent, the number of emission tests were pointed out by stakeholders from all groups as complex or even very complex features of Euro 6/VI.[99] In the targeted consultation, industry stakeholders pointed to the complexity of the test procedures as resulting in errors in performing of emission tests and calculations. Testing complexity required additional costly capacity-building by manufacturers in order to comply with the legislation. This significantly increased the overall costs during implementation phase (see 2.1.1).[100] Moreover, the evaluation identified various technical inconsistencies in the legislation.[101]

2.2.2 Drivers behind obsolete vehicle pollutant limits

- *Non-exhaustive use of technological potential for reducing emissions*

Technological potential exists for reducing emissions by using best available emission control technology. There are advances in thermal management, engine controls, filters and catalyst technology in petrol and diesel powertrains available on the market that allow vehicles to achieve emission significantly lower than the Euro 6/VI levels.[102] In addition, existing sensor technologies may contribute to the digital transformation and allow keeping emissions under well under control throughout the lifetime of a vehicle.

Therefore obsolete vehicle emission limits for regulated pollutants may be corrected, i.a. by introducing updated emission limits that lead to the use of available technology. In the public consultation, the large majority of respondents (55 out of 67) from Member States, civil society and citizens indicated that current technology offers room for additional emissions reductions. Industry had different views on the matter[103].[104]

- *Some technologies to reduce emissions of regulated pollutants cause emissions of new pollutants*

Reduction of a given pollutant may result in higher emissions of another unregulated pollutant. This is for example the case for NH_3 emissions resulting from cars/vans. The emission control technologies that are necessary to comply with NO_x emission limits may cause a so-called ammonia slip due to excess dosing of urea.[64] To tackle such collateral emissions, additional technologies are already used on a voluntary basis.

---

[99] See Annex 2: Stakeholder consultation, 2.2.1. Evaluation Euro 6/VI emission standards

[100] CLOVE, 2022. Euro 6/VI Evaluation Study. ISBN 978-92-76-56398-3, chapter 5.2.1.3.1 Costs for vehicle manufacturers

[101] Such inconsistencies include differences in the provisions for type-approval and In-Service Conformity for specific vehicles or obsolete smoke opacity tests. (See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.4 Coherence, Evaluation question 7)

[102] CLOVE, 2022. Technical studies for the development of Euro 7. Testing, Pollutants and Emission Limits. ISBN 978-92-76-56406-5.

[103] 19 of the 59 industry respondents agreed that the current emission control technology creates room for additional reductions in emissions, while 20 disagreed to the statement and 20 neither agreed nor disagreed.

[104] See Annex 2: Stakeholder consultation, Public Consultation, Question 12

- *Not yet regulated emissions of concern today*

The introduction of new technologies in the vehicle fleet over the last decade, such as gas-fuelled heavy-duty vehicles that are expected to reach 5% market share by 2025[95], emit new pollutants. They are currently not covered by Euro 6/VI standards, although they are of concern, as confirmed in the evaluation of Euro 6/VI and the public consultation by all stakeholders[105][106].

The current PN limits take into account particles larger than approximately 23 nm. As research shows, particles smaller than 23 nm, may have detrimental health effects as they can enter the bloodstream, thus reaching all organs. However, they are not yet covered in Euro 6/VI[107].

CH_4 emissions are up till now only regulated for lorries/buses. Natural gas lorries are expected to play a role in decarbonisation agenda, especially if blended with bio-methane or if full bio-methane is used. As CH_4 fuel use is projected to increase (e.g. new registrations of CNG cars[108]), limiting this greenhouse gas and ozone precursor also for cars/vans becomes important.

Brake and tyre emissions have become increasingly relevant sources of particles, especially since the exhaust particles were drastically diminished with the use of particle filters. This is due mainly to the number of vehicles on the road and km travelled leading to an increase of road transport activity from 3 200 Gvkm in 2010 to 3 500 Gvkm in 2018 (see Figure 6 in section 5.1) but also due to the increasing share of heavier and fast-accelerating vehicles such as SUVs and electric vehicles, although the later somewhat reduce such emissions by regenerative braking. In 2018, PM_{10} emissions from tyre and brake wear were equivalent to the PM_{10} levels of emissions that originate from the tailpipe of light- and heavy-duty vehicles[6]. According to the existing literature, it is expected that the non-exhaust contribution to vehicle-related PM_{10} emissions will reach 90% of total PM_{10} emissions in 2040 (see Figure 2). This is mainly due to the drop of exhaust emissions and the fact that brake- and tyre-wear is emitted by all types of vehicles, including zero-emission vehicles. In particular brake wear is recognized as the leading source of non-exhaust particles, harmful to human health due to its smaller size and composition and is emitted also by zero CO_2 emission vehicles. A method for measuring brake wear emissions is under validation in the Particle Measurement Programme of the UNECE[109].

2.2.3 Drivers behind insufficient control of vehicle real-world emissions

- *Limited effectiveness of On-Board Diagnostics*

On-Board Diagnostics (OBD) monitor the functioning of powertrain systems and emission control technologies, in order to identify possible areas of malfunction during the life of the vehicle and inform the user of the need to carry out vehicle maintenance.

[105] See Annex 2: Stakeholder consultation, Public Consultation, Question 12.2
[106] CLOVE, 2022. Euro 6/VI Evaluation Study. ISBN 978-92-76-56398-3, chapter 5.3.1.4 Do the standards properly cover all relevant/important types of pollutant emissions from vehicles that pose a concern to air quality and human health? Are there important types of pollutant emissions that are not covered?
[107] Giechaskiel, B. & Martini, G., 2014. Review on engine exhaust sub-23 nm solid particles
[108] European Alternative Fuels Observatory, 2020. Vehicles and fleet
[109] UNECE, 2021. UNECE to develop global methodology to measure particle emissions from vehicles' braking systems

The OBD is verified during In-Service Conformity (ISC) checks, Periodic Technical Inspections (PTI) – which take place at fixed intervals – and Roadside Inspections (RSI) – for which commercial vehicles are selected on the road.[33]

However, 78 of the 120 respondents to the public consultation from all stakeholder groups indicated that the limited effect of OBD measurement at least somewhat contributes to maintaining high levels of pollutant emissions[110]. In addition, 17 out of 28 respondents from Member States and environmental NGOs to the public consultation indicated that OBD does not ensure that new vehicles are compliant with the pollutants limits over their entire lifetime, while industry respondents are generally less sceptical on the functionality of OBD[111].[88] Evidence provided to the Euro 6/VI evaluation study by four key stakeholders – one from industry, one type-approval authority, one research institution and one environmental NGO – and the relevant JRC report revealed that the current OBD systems have only limited capacity to address durability and are ineffective in detecting and diagnosing degradation, failure or tampering of pollution-control devices.[112],[113] In addition, today's developments in the field of continuous emission monitoring allow for more comprehensive monitoring which is so far not properly reflected in the Euro 6/VI durability requirements.[114]

This shows that despite the enhancement of the OBD thresholds in Euro 6/VI, the current OBD requirements do not allow for proper checks of emissions during the lifetime of vehicles or emission testing during ISC, PTI and RSI. [101]

- *Limited representativeness of on-road tests*

Another driver of insufficient control of vehicle real-world emissions is the limited representativeness of the on-road tests. The shift towards RDE and PEMS testing in Euro 6/VI emission standards introduced a wide range of load, speed, temperature and altitude conditions to make sure that the emission limits are respected under a broad range of real-world driving conditions. However, not all driving conditions are covered by RDE and PEMS testing. Emissions tend to be higher outside the coverage of RDE and PEMS and important emissions remain therefore unaccounted for in the current testing[115]. NO_x emissions, for example, were found to increase by 1.6 to 1.7 times in low ambient temperatures.[116],[102]

- *Inadequate durability and emission control tampering provisions*

A final driver for insufficient control of vehicle real-world emissions is the risk of ageing, lacking maintenance and tampering[117] of vehicles and their emission control

[110] See Annex 2: Public Consultation, Question 15

[111] 40 of 58 industry stakeholders that answered the question agreed that OBD ensures that new vehicles are compliant with the pollutant limits over their entire lifetime.

[112] CLOVE, 2022. Euro 6/VI Evaluation Study. ISBN 978-92-76-56398-3, chapter 5.4.2.1.3 Vehicle roadworthiness legislation

[113] JRC 2021 Technical Report: "Vehicles Odometer and Emission Control Systems - Digital Tampering and Countermeasures", Jose Luis Hernandez Ramos (JRC), L. Sportiello (JRC).

[114] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.3 Relevance, Evaluation question 6

[115] This is the case for short trips, idle times, low speed, strong acceleration, high loads, high altitude circuits and severe temperature conditions in which emissions are usually considerably higher.

[116] As another example, low speed driving, which is not covered in the current RDE tests, has been linked to high pollutant emissions (See Annex 5: Evaluation Euro 6/VI emission standards, Figure 22 – Emission performance of Euro 6d vehicles for NO_x for different average speeds, based on CLOVE, 2022)

[117] Regulation (EC) No 595/2009 defines tampering as "inactivation, adjustment or modification of the

technologies. The evaluation of Euro 6/VI emission standards emphasised that the current durability requirements cover only the first half of the vehicle life (see 2.1.3). Considering this and the increasing complexity of pollution-control devices, there is a need for a more complete demonstration of durability in order to provide effective emission control over the lifetime. [84]

The replies from stakeholders from all groups to the public consultation have proven that tampering (117 of the 124 replies), vehicle ageing (114 of the 127 replies) and the cost of vehicle maintenance (101 of the 123 replies) have contributed to an increase in real-world pollutant emissions. These results indicate that Euro 6/VI rules are not effective to prevent tampering and to control effectively emissions throughout the vehicle lifetime.[110]

2.3 How will the problem evolve?

When considering the negative effects of air pollutant emissions from vehicles on human health and environment, improvements are expected over time in the absence of new action, for the cars/vans as well as the lorries/buses segment (see Figure 2 in section 2.1).

Fleet renewal will lead to an increased share of Euro 6/VI vehicles in the vehicle mix. As only 20% of cars/vans, and 34% of lorries/buses in the fleet are of Euro 6/VI standards in 2020, including RDE testing, the benefits of cleaner Euro 6/VI vehicles compared to previous Euro vehicles will continue to be felt in the coming years on EU road as older vehicles are replaced by these new cleaner Euro 6/VI vehicles.[84]

In addition, significant positive effects on air quality can be expected from the adoption of the package of proposals to make EU's climate policies fit for reducing net greenhouse gas emissions by at least 55% by 2030 ('fit-for-55 package') in July 2021[118]. The proposed amendment of the CO_2 emission performance standards for new cars and vans sets an end-date of 2035 for placing new combustion-engine cars and vans in the EU market[12]. Additional effects from the planned revision of Ambient Air Quality Directive in 2022, which are estimated to be limited compared to the effects of CO_2 emission standards, cannot be taken into account yet, but as explained earlier compliance with air quality standards cannot be achieved without more stringent emission limits for motor vehicles. See details in section 5.1.

At the same time, Figure 2 shows that there is need to act towards zero-pollution in the cars/vans as well as the lorries/buses segment to improve our health and well-being in line with the Zero-Pollution Action Plan and in particular in cities. See details in Box 1 in section 2.1.

vehicle emissions control or propulsion system, including any software or other logical control elements of those systems, that has the effect, whether intended or not, of worsening the emissions performance of the vehicle"

[118] Press release 14 July 2021. European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions

3 WHY SHOULD THE EU ACT?

3.1 Legal basis

The Euro emission standards are based on Article 114 of the Treaty of the Functioning of the European Union. According to this Article, the European Parliament and the Council shall adopt measures which have as their object the establishment and functioning of the single market. Furthermore, the Euro emission standards have the objective to ensure a high level of environmental and health protection.

3.2 Subsidiarity: necessity and added value of EU action

The evaluation of Euro 6/VI emission standards emphasized the necessity and added value of EU action in this policy domain by illustrating that both action at national or international level are unlikely to lead to optimal outcomes[119] since both air pollution and road transport have a transboundary nature. Secondly, the development and governance of emission standards at EU level is key to ensure properly functioning single market. Differences in air quality policy ambitions among Member States could easily lead to a patchwork of different national measures (e.g. to measures limiting access to certain areas) that would create considerable obstacles for industry and pose great risk to the single market. Hence, continued harmonised EU action to further reduce vehicle emission is fully justified. In conclusion, the objectives of the proposed action cannot be achieved sufficiently by the Member States acting alone and can be better achieved at Union level by reason of scale or effects of that action.

4 OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1 General objectives

The general objective of the initiative is twofold: (1) to ensure the proper functioning of the single market by setting more adequate, cost-effective and future-proof rules for vehicle emissions; and (2) to ensure a high level of environmental and health protection in the EU by further reducing air pollutants emission from road transport towards zero-pollution, as required by the Zero Pollution Action Plan, as rapidly as possible.

4.2 Specific objectives

This initiative will contribute to achieving the general objective by pursuing the following three specific objectives in line with the identified problems, relevant for the cars/vans as well as the lorries/buses segment (see chapter 2). It will:

1) *Reduce complexity of the current Euro emission standards.* This specific objective directly addresses the defined problem of complexity in the standards. Tackling complexities would allow for reduced administrative costs and costs during implementation phase and would facilitate efficient implementation of the Euro standards.

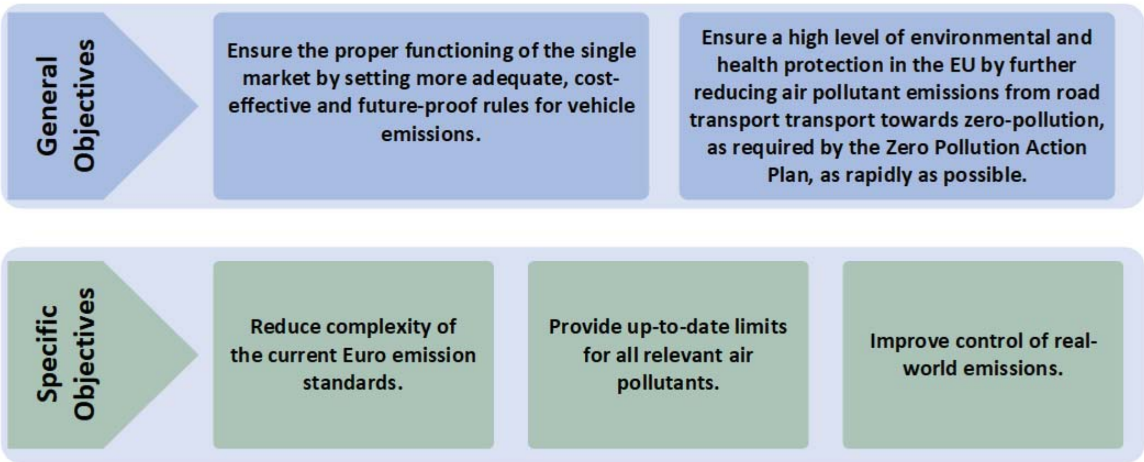
---

[119] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 5.5 EU-added value

2) *Provide up-to-date limits for all relevant air pollutants*. This specific objective addresses the problem of obsolete vehicle pollutant limits in the Euro 6/VI emission legislation which prevent further reduction of air pollutants emission from road transport. Up-to-date limits based on best available technology and today's knowledge on emission controls will allow to curb harmful emissions. That way, the functioning of the single market could be ensured, together with high level environmental and health protection in the EU.

3) *Improve control of real-world emissions.* This specific objective is a direct response to the problem of current RDE boundaries that do not cover all conditions of use throughout the lifetime of the vehicle which prevent further reduction of air pollutants emission from road transport. Achieving this objective would reduce vehicle emissions in a more systematic manner and improve environmental and health protection in the EU. It could also help guarantee the functioning of the single market by addressing challenges associated with urban vehicle access restrictions.

Figure 5 – Euro 7 objectives



5 WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1 What is the baseline from which options are assessed?

The baseline to assess impacts of the policy options takes the following into account: a) the Euro 6/VI emission standards, b) the impact of COVID-19 on road transport activity[120] and c) the impact of the new 55% (cars) and 50% (vans) CO_2 targets by 2030 and 100% CO_2 targets for cars and vans by 2035[121] and the projected fit-for-55 HDV fleet evolution to contribute to the 55% net greenhouse gas emission reduction by 2030 and the 2050 climate neutrality objective[122] .

[120] Road transport activity is the volume-km driven by vehicles on EU roads and is projected by the estimated evolution of vehicle sales.
[121] A linear interpolation was used for the year 2030 for both the activity and shares of vehicles between the two existing scenarios in the CO_2 Impact Assessment (TL_Med and TL_High), while the TL_High scenario was used for the year 2035. This approach is the estimated representation of the impact of the Commission proposal for CO_2 targets for cars/vans.
[122] For heavy–duty vehicles, the activity and fleet shares of vehicles are based on the SWD(2020) 176 final,

The baseline cannot take into account the effect of future potentially more stringent air quality targets which may lead to more cities banning combustion-engine vehicles and therefore modify road transport activity or vehicle sales, in the absence of more stringent emission standards for motor vehicles. Such possible effect of future air quality targets would be difficult to quantify since it will depend on local actions taken at Member States level and will not be uniformly applied throughout the EU. However, this additional effect from the planned revision of Ambient Air Quality Directive in 2022 is estimated limited compared to the effects of CO_2 emission standards.

The baseline is a "no policy change" scenario which implies that the relevant EU-level legislation, addressing air pollutant emissions resulting from road transport will continue to apply without change. That means that Euro 6/VI applies, taking into account impact of the CO_2 targets for vehicles, including the aforementioned new CO_2 targets for cars/vans, and COVID-19 on road transport activity. It is referred to in chapter 6 as the baseline.

a) Euro 6/VI emission standards

The Euro 6/VI emissions standards[19] and in particular the air pollutant emission limits and real-driving testing conditions set out therein are summarised in Annex 5, Table 34 and Table 35. They are assumed to remain in force. Moreover, as shown in Annex 5, Figure 19, the baseline assumes that fleet renewal would lead to a higher share of Euro 6/VI vehicles in the vehicles mix, mostly with cars/vans introduced under Euro 6 d step. The benefits of cleaner Euro 6/VI vehicles compared to previous Euro norms will increase in the next years as older vehicles are replaced with clean ones.[84]

b) Impact of COVID-19 on road transport activity

The COVID-19 pandemic continues to have significant impacts on the automotive sector, which will shape the sector for years to come. First, various lockdown measures had significant impact on sales. Following the 6,1% decrease of the EU GDP in 2020[123], demand for new passenger and light commercial vehicles dropped by respectively 23.7% (to 9.9 million units) and 18.9% (to 1.7 million units) in 2020 as a direct result of the pandemic.[124] The full long-term effects on the industry will only become clear after the pandemic has come to an end and will largely depend on the pace of the economic recovery[125]. Over the first half of 2021, passenger car sales increased by 25.2% to almost reach 5.4 million units registered in total. However, this is still 1.5 million units below the 2019 pre-crisis level for the same period.[126] In addition, industry is facing shortages of semi-conductors. This shortage limits the capacity of industry to satisfy demand which is already at historically low levels. Demand is only expected to return to the pre-pandemic levels by 2023.[127] This may affect the capacity of the industry to invest in new technologies. See Annex 7 for more details on the impact of COVID-19 on automotive industry.

Impact Assessment on Stepping up Europe’s 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people (part 1) and SWD(2020) 176 final (part 2), supplemented for buses by CLOVE, 2022.

[123] Eurostat, 2021. Real GDP growth rate - volume

[124] ACEA, 2021. Press release: Passenger car registrations: -23.7% in 2020; -3.3% in December 2020; ACEA, 2021. Press release: Commercial vehicle registrations: -18.9% in 2020; -4.2% in December 2020

[125] European Commission, 2021. Spring 2021 Economic Forecast: Rolling up sleves

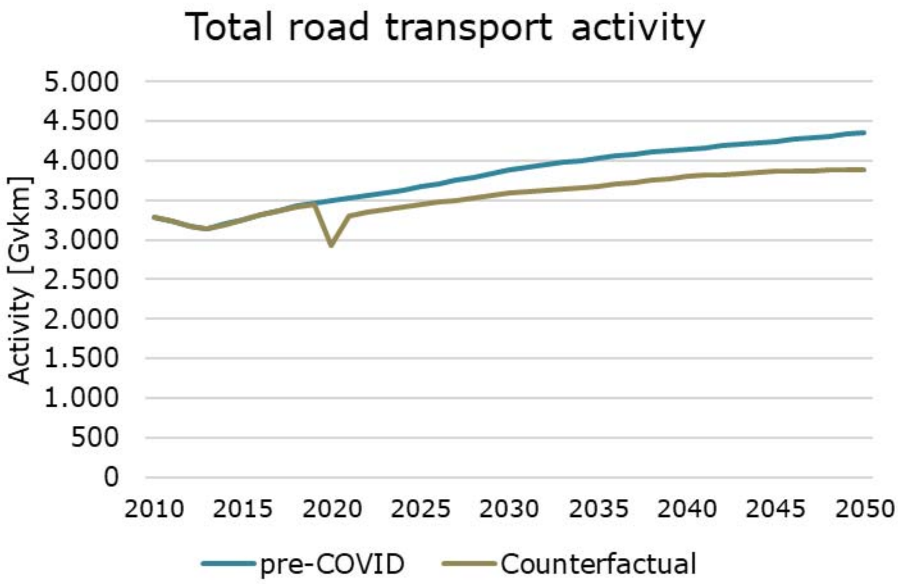
[126] ACEA, 2021. Passenger car registrations: +25.2% first half of 2021; +10.4% in June

[127] BCG, 2020. COVID-19’s Impact on the Automotive Industry

The baseline takes into account the indirect impact of the COVID-19 pandemic on vehicle emissions, mostly through its effect on transport activity and fuel consumption. Estimations from the impact assessment on the 2030 climate target plan[128] indicate that the projected decrease of total fuel consumption of road transport was about 17% in 2020 compared to 2019. In addition, the JRC estimated that between February and April 2020 a total drop in vehicle activity of 60-90% for passenger cars compared to a 15% drop for freight transport.[129]

Based on this evidence and taking into account the impacts of COVID-19 on GDP, the impact of the pandemic on road transport activity in various vehicle segments has been estimated. The short-term estimates point to a sharp activity drop of 15% in 2020, followed by significant recovery in 2021. Nevertheless, by 2030 the pandemic and following crisis are projected to result to a permanent loss in total road transport activity of 6% compared to the pre-COVID levels. Figure 6 presents the projected evolution of transport activity taking into account the COVID-19 drop as counterfactual. In addition, reduced private transport activity is assumed due to promotion of public means of transport and advancing modal shifts to other than road transport means, especially when it comes to passenger transport.[128] The total activity for passenger transport in 2050 is projected to 6.4% lower, whereas the activity levels for freight transport are not assumed to differ. The counterfactual evolution of road transport activity is taken into account in the baseline.

Figure 6 – Evolution of total road transport activity in EU-27 considered in the baseline (in volume-km)[130]



c) CO_2 emission performance standards

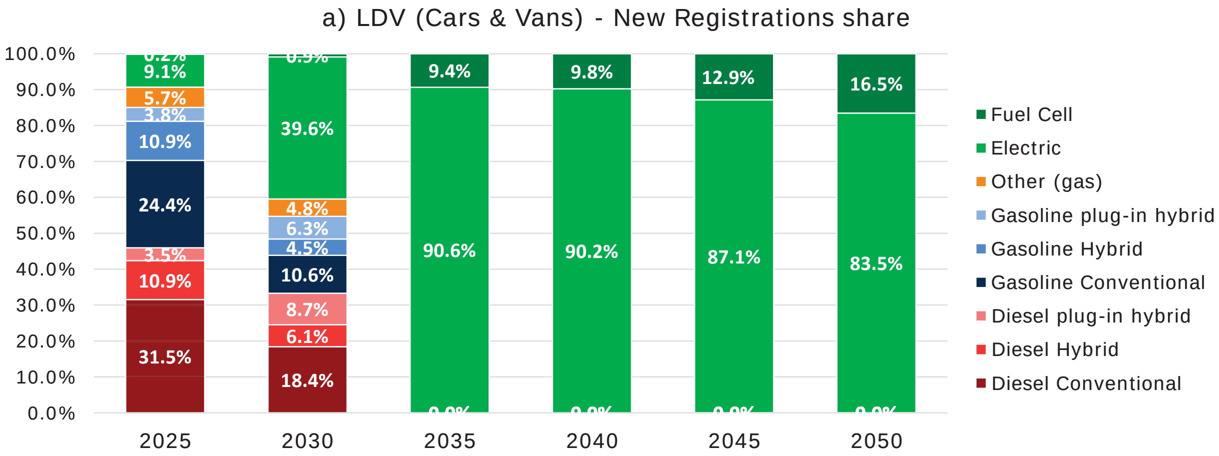
[128] SWD(2020) 176 final, Impact Assessment on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people (part 1) and SWD(2020) 176 final (part 2)
[129] JRC, 2020. Future of Transport: Update on the economic impacts of COVID-19
[130] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 4.2 The impact of COVID-19 on the baseline development.

The CO_2 targets for vehicles laid down in the CO_2 Regulation, including the new CO_2 targets for cars/vans proposed in July 2021[12], also contribute to reduction of air pollutant emission from road transport. This is due to the increased sales of zero- and low-emission vehicles that are triggered by stringent CO_2 targets for light- and heavy-duty vehicles, scaling up towards an end-date of 2035 for placing new combustion-engine cars and vans in the EU market. Electric and fuel cells powered vehicles do not have tailpipe emissions but do emit particles from brakes and tyres. Low-emission vehicles, such as plugin hybrids, also have less tailpipe air pollutant emissions. The CO_2 targets, including the new CO_2 targets proposed for cars/vans and the projections for heavy-duty vehicles, and their impact on the vehicle fleet, are included in the Euro 7 baseline.

As can be seen in Figure 7, the share of new zero- and low-emission vehicles in the European vehicle fleet is projected to increase substantially over time, for LDVs much faster than for HDVs. The share of new zero-emission cars/vans is expected to increase from 9% in 2025 to 100% in 2035, whereas the share of hybrid and low-emission vehicles is expected to decrease from 35% in 2025 to 0% in 2035. The share of ICE cars/vans is expected to decrease from 56% in 2025 to 0% in 2035.

The projected vehicle fleet evolution is different for HDVs[131]. In particular long-haul lorries are not projected to shift swiftly to zero- and low-emission performance due to their need for high powered engines and long trips, while the electrification of buses is expected to happen faster due to their predominant use in urban areas. The share of ICE HDVs is expected to decrease from 70% in 2025 to 6% in 2050, whereas share of hybrid and other low-emission lorries is expected to increase from 26% in 2025 to 33% in 2050. New zero-emission lorries are expected to constitute 61% of the total in 2050.

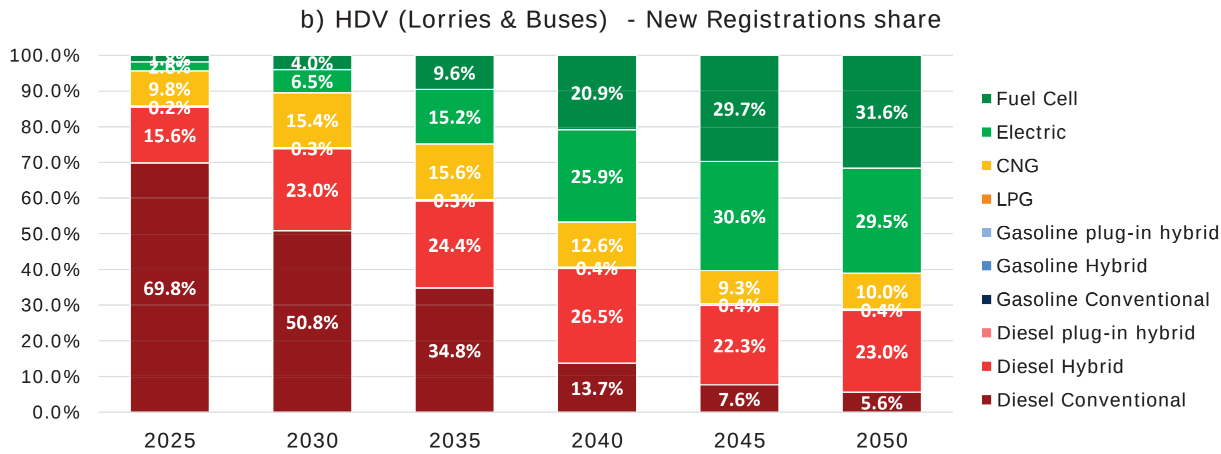
Figure 7 – Projected powertrain changes in the vehicle fleet in EU-27 of new registration of (a) cars/vans, (b) lorries and (c) buses in the baseline until 2050[132],[133]



[131] The projected vehicle fleet evolution is consistent with the overall 55% net greenhouse gas emission reduction by 2030 to achieve the 2050 climate neutrality objective.

[132] A linear interpolation was used for the year 2030 for both the activity and shares of vehicles between the two existing scenarios in the CO_2 Impact Assessment (TL_Med and TL_High), while the TL_High scenario was used for the year 2035. This approach is the estimated representation of the impact of the Commission proposal for CO_2 targets for cars/vans.

[133] For heavy–duty vehicles, the activity and fleet shares of vehicles are based on the SWD(2020) 176 final, Impact Assessment on Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people (part 1) and SWD(2020) 176 final (part 2), supplemented for buses by CLOVE, 2022.



The contribution of a) Euro 6/VI vehicles, b) road transport activity and c) CO_2-related powertrain changes in the fleet to the evolution of NO_x and $PM_{2.5}$ emissions are shown in Figure 2 in section 2.1. The NO_x emissions are expected to decrease by 87% between 2015 and 2050. Exhaust $PM_{2.5}$ coming from combustion-engine vehicles decrease steadily over the next 30 years, while total $PM_{2.5}$, include tyre- and brake emissions come from all types of vehicles and therefore remain significant.

5.2 Description of the policy options

Table 2 gives a schematic overview of the policy options developed for this impact assessment, while a detailed description of the policy options is available in Annex 6.

In light of creating an adequate, cost-effective and future-proof Euro 7 regulation ensuring a high level of environmental and health protection in the EU, the policy options consider the green and digital transformation required by the European Green Deal. The transformation provides opportunities for more advanced solutions in terms of pollutant emission reductions, such as the use of low emission technology and continuous emission monitoring with advanced sensors and vehicle connectivity. The policy options take also into account the shift to electrified powertrains requiring cost-effective and adequate solutions for reducing pollutant emissions in the combustion-engine segment. All options are relevant for the cars/vans as well as the lorries/buses segment, whereas the impacts of the policy options are calculated separately for each segment in chapter 6.

All options presented in the tables require implementing legislation, with adequate lead time for the industry. Elements such as measurement methodologies, procedures and equipment, accuracy and repeatability of measurements, selection of vehicles and statistical procedures will be part of the implementing legislation. Most of these elements are either already available or under development both in the EU and in UNECE framework. The work for the implementing legislation will start in 2022.

Table 2 - Description of the policy options

	Baseline	**PO1 – Low Green Ambition**	**PO2a – Medium Green Ambition**	**PO2b – High Green Ambition**	**PO3a – PO2a and Medium Digital Ambition[1]**
Simplification	-	Simplification measures	Simplification measures	Simplification measures	Simplification measures
Emission limits	Euro	Euro 6/VI but	Medium	High Ambition	Medium

	6/VI	technology-neutral (60 mg/km NO_X,..)	Ambition (30 mg/km NO_X,..)	(20 mg/km NO_X,..)	Ambition (30 mg/km NO_X,..)
Real-driving boundaries	Euro 6/VI	Low ambition of boundaries (low/high temperature…)	Medium ambition of boundaries (+short trips…)	High ambition of boundaries (+high speed, high altitude…)	Medium ambition of boundaries (+short trips….)
Durability	Euro 6/VI	Euro 6/VI (160 000 km or 8 years)	Average Increase (200 000 km or 10 years[2])	Full Increase (240 000 km or 15 years[3])	Average Increase (200 000 km or 10 years[2])
Continuous Emission Monitoring	-	-	-	-	With available sensors

[1] A second sub-option in policy option 3 (i.e. PO3b – PO2a and High Digital Ambition) which added to PO2a high ambitious continuous emission monitoring, i.e. the development of new sensors that would require several years before they can be implemented, was discarded following the proposed end-date of combustion engine cars/vans by 2035 (see 5.3).
[2] For lorries < 16t, buses < 7.5t: 375 000 km and for lorries > 16t, buses > 7.5t: 875 000 km
[3] For lorries < 16t, buses < 7.5t: 450 000 km and for lorries > 16t, buses > 7.5t: 1 050 000 km

In line with the specific objectives, all options aim at reducing complexity of the current Euro emission standards by introducing simplification measures. Up-to-date emission limits for all relevant air pollutants should be provided in PO1 with low ambition, in PO2a and PO3a with medium ambition and in PO2b with high ambition. Control of real-world emissions should be improved in PO1 by low ambitious real-driving testing boundaries, in PO2a by medium ambitious real-driving testing boundaries and durability requirements, in PO2b by high ambitious real-driving testing boundaries and durability requirements and in PO3a by medium ambitious real-driving testing boundaries, durability requirements and continuous emission monitoring. That means, the completely new digital ambition of continuous emission monitoring to control real-world emissions is considered in PO3 only.

As the policy options are built on existing emission control and sensor technology, it is possible to introduce an application date of 1 January 2025 for all new registrations. As adequate lead time is needed for the industry to implement new rules, all secondary rules need to be finalised soon after entry into force of the Regulation.

The possibility for Member States to apply financial incentives at national level for early implementation of Euro 7 (i.e. between its entry into force date and its application date, i.e. the date by which all vehicles entering the market need to be Euro 7) are assumed in the policy options.

The modular approach of the policy options was proposed in the inception impact assessment and confirmed in the stakeholder consultations.

The simplification measures, emission limits, real driving boundaries, durability and sensor requirements have been elaborated in the supporting studies[63,77,134] and discussed with stakeholders in the AGVES meetings.

[134] CLOVE, 2022. Technical studies for the development of Euro 7: Durability of light-duty vehicle

5.2.1 Policy option 1 (PO1): Low Green Ambition

PO1 implies a narrow revision of Euro 6/VI emissions standards to tackle complexity of the legislation (problem 1) somewhat addressing obsolete vehicle pollutant limits (problem 2) and insufficient control of vehicle real-world emissions (problem 3) with a low green ambition. This policy option was developed as a less intrusive approach.[135]

PO1 addresses key simplification and consistency challenges through refining the architecture of the Euro 6/VI emission standards. It assumes that a single framework for cars, vans, lorries/buses is developed, multiple application dates of Euro 6/VI steps are avoided and the multitude and complexity of emissions tests is reduced. To ensure technology-neutrality, this option foresees making the Euro 6/VI emissions limits consistent across different ICE technologies (see Annex 6, Table 48). This improves only marginally emission from diesel cars and vans, but all other emission remain the same, so especially for lorries/buses there is no significant change. NH_3 limit is extended for cars and vans for the same reason it was already introduced for lorries and buses in Euro VI, i.e. to control ammonia slip from the current generation of catalysts.

The measures aiming at refining and simplifying Euro 6/VI emissions testing (see Annex 6, Table 47) remove obsolete testing and other obsolete provisions. PO1 allows testing of vehicles beyond the Euro 6d RDE and Euro VI E PEMS conditions (see Annex 6, Table 49). Both actions address the problem of insufficient control of vehicles' real-driving emissions with a low ambition. PO1 explicitly refrains from digital control of vehicles' real-driving emissions, i.e. continuous emission monitoring that would be a completely new element in the Euro standards and worldwide.

In light of creating a future-proof regulation, low-ambitious PO1 refrain from a green and digital transformation in view of the shift to electrified powertrains.

5.2.2 Policy option 2 (PO2a and PO2b): Medium and High Green Ambition

PO2 implies a wider revision of Euro 6/VI emissions standards in order to tackle the complexity of the legislation (problem 1), to address obsolete vehicle pollutant limits (problem 2) and to partly address insufficient control of vehicle real-driving emissions (problem 3). While a PO2a will tackle the last two problems with a medium green ambition level, PO2b will address them with a high green ambition level.

PO2 builds on the same simplification measures as PO1. In addition, two ambition levels (medium and high ambition) of pollutant emission limits and boundary conditions are considered, to ensure up-to-date limits for all relevant air pollutants including some unregulated ones (see Annex 6, Table 50 and Table 51). The new pollutants added are HCHO, N_2O, and particles from brakes[136]. HCHO, CH_4 and N_2O emission limits are set at the level of today's emissions (i.e. a simple cap on emissions) to ensure that these emissions do not disproportionately increase in future vehicles or with new fuels.

---

emissions. ISBN 978-92-76-56405-8

[135] See Annex 2 Stakeholder consultation, Section 2.2 Analysis of responses

[136] Next to brake emissions, tyre emissions are found to be a source of non-exhaust emissions as they contribute to the formation of particles. As it is not yet technologically feasible to develop limits or tests for tyre emissions, they cannot be assessed in this impact assessment and it is suggested to include a review clause in Euro 7 proposal.

In addition, PO2 will cover comprehensive real-driving testing conditions with medium or high ambition, to account for broader conditions than Euro 6d/VI E emission tests, e.g. low ambient temperatures or low speed driving (see Annex 6, Table 52 and 53).

PO2 also considers the need to address inadequate durability provisions. PO2 extends the requirements to comply with the emission limits for vehicles in use, i.e. the durability provisions, over the current inadequate period in Euro 6/VI. While PO2a introduces a medium ambition of durability provisions, e.g. 200 000 km for LDV; PO2b considers a high ambition, e.g. 240 000 km for LDV (see Annex 6, Table 54). Durability requirements will also cover propulsion batteries in PHEVs and BEVs, according to the developments at international level[137].

In light of creating a future-proof regulation, PO2a considers a medium-ambitious and PO2b a high-ambitious green transformation towards zero-emission vehicles. Both sub-options refrain from a digital transformation, i.e. continuous emission monitoring that would be a new element in the Euro standards and world-wide.

In the stakeholder consultations, automotive industry and civil society representatives raised concerns, often having conflicting opinions, regarding the level of emission limits, length of durability requirements and the technological potential for reducing emissions over the lifetime of the vehicles. In addition to the different emission limits and durability in the policy options for low, medium and high green ambition (see Table 2), an alternative set of assumptions on emission limits and durability was therefore assessed to address remaining uncertainty in the medium green ambition (see Annex 8).

5.2.3 Policy option 3 (PO3a): PO2a and Medium Digital Ambition

PO3 implies a profound revision of Euro 6/VI emission standards to tackle complexity of the legislation (problem 1), to address obsolete vehicle pollutant limits (problem 2) and to address insufficient control of vehicle real-driving emissions (problem 3) with a medium green and digital ambition.

PO3 builds on the same simplification measures as PO1, on the medium ambitious air pollutant emission limits, real-driving testing conditions and durability provisions of PO2a given that the high ambitious emission limits of PO2b cannot be reliably measured with either current or future sensor technology as was elaborated in the supporting technical studies (see Annex 6, Table 50, 52 and 54).

In addition, new continuous emission monitoring of pollutants over the whole lifetime of the vehicle is added in PO3. PO3a on Medium Digital Ambition is based on improved versions of available sensor technologies for NO_x, NH_3 and partly PM (see Annex 6, Table 55). Synergies with the on-board fuel consumption meters (OBFCM) introduced under the CO_2 emission performance standards[138] will be exploited. PO3 would also

---

[137] UNECE, 2021. UN GTR No 22 on In-Vehicle Battery Durability for Electrified Vehicles in https://unece.org/transport/documents/2022/04/standards/un-gtr-no22-vehicle-battery-durability-electrified-vehicles

[138] Regulation (EU) 2019/631 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles and Regulation (EU) 2019/1242 setting CO_2 emission performance standards for new heavy-duty vehicles both require in Article 12 that the Commission shall regularly collect data on the real-world CO_2 emissions and fuel or energy consumption of passenger cars, light commercial vehicles and heavy-duty vehicles using on-board fuel and/or energy consumption monitoring devices.

facilitate the implementation of geo-fencing that puts a vehicle automatically into zero-emission mode when entering zero-emission zones.

New continuous emission monitoring is only part of PO3 because it adds a completely new digital dimension to the Euro standards making PO3 overall the most profound policy option. Such an approach has not been introduced up to now in any other emission regulation world-wide. While this new measure was highly praised by stakeholders from some Member States, component suppliers, civil society and citizens during the consultation activities, vehicle manufacturers took a more sceptical position on the matter.[139] Taking the above into account, it was decided to not add new continuous emission monitoring in PO1 to allow the assessment of lower ambition and less intrusive policy option.

In light of creating a future-proof regulation, PO3a considers a medium-ambitious green and digital transformation. Available pollutant sensors and the rise of connected vehicles provide the opportunity for increased enforcement, by continuously monitoring the state of the emission control systems. High emitting vehicles will thus be fixed earlier, or tampering[117] of vehicles will be avoided. Additional cost gains, which are not included in this impact assessment, can be expected for the revision of the Roadworthiness Directives by replacing costly inspection mechanisms with over-the-air control of emissions.

A second sub-option, PO3b on High Digital Ambition, which would have been based on future sensor technologies, such as PM/PN and NMOG, was discarded following the proposed end-date of combustion-engine cars and vans by 2035 (see 5.3).

5.3 Options discarded at an early stage

During the technical work in support to the Euro 7 proposal, a variety of technology driven policy option packages were evaluated both for light- and heavy-duty vehicles. Such technology-driven policy option packages would lead to varying stringencies of the emission limits. For light-duty vehicles 16 such variations were analysed (12 for gasoline and 4 for diesel) both in terms of technology readiness as well as for their potential for emission reduction. For heavy-duty vehicles 6 technology-driven policy option packages were evaluated for diesel and gaseous fuelled engines. From these technology packages only three levels were considered as compatible with the expected timeline of Euro 7 and technically feasible without restricting driving habits and were therefore retained in the policy options further analysed.[140]

Stakeholders' responses to the different consultation areas (see Annex 2), make clear that all three policy options initially developed for the inception impact assessment, i.e. PO1, PO2 and PO3, presented for public and targeted consultation and discussed in AGVES meetings received some support, although some simplification measures have been rejected - see list after consultation in Annex 6, Table 47. No stakeholder group required different ambition level and therefore policy options for the cars/vans and lorries/buses segment.

[139] See Annex 2 Stakeholder consultation, Section 2.2.5. Continuous emission monitoring
[140] CLOVE, 2022. Technical studies for the development of Euro 7. Testing, Pollutants and Emission Limits. ISBN 978-92-76-56406-5.

A second sub-option of PO3 (i.e. PO3b – PO2a and High Digital Ambition) was discarded following the proposed end-date of 2035 for placing new combustion-engine cars and vans on the EU market. PO3b added to PO2a high ambitious continuous emission monitoring, i.e. more advanced sensors such as PN/PM or NMOG sensors that are not yet available in the market and would require a few years of development before being employed (see 5.2). This would require high investment costs for vehicle manufacturers and component suppliers which would not be recuperated until 2035. Sensors for vehicles are designed for application in all vehicles, light and heavy-duty ones. With the planned end-date for combustion engines for cars and vans, the market for such sensors diminishes significantly. Even though such sensors could eventually be implemented in the heavy-duty sector for a longer period, such an investment for the limited number of heavy-duty vehicles sold each year would not allow to recuperate the high investment costs. Hence, PO3b was discarded, for light-duty as well as heavy-duty vehicles, to only include policy options that are achievable with existing technologies and in a timely manner for introduction into vehicles by 2025.

PO1 to PO3 are built in a modular approach by combining several policy measures with increasing ambition levels. Hence, one could in principle build variations of these policy options by making different combinations of measures. By changing the comprehensive real-driving conditions from medium to high ambition in both PO2a and PO3a, all else being equal, two other combinations of measures were assessed.[141] Since neither of these alternative combinations outperformed the effectiveness and efficiency of PO2a and PO3a with medium ambition comprehensive real-driving conditions, these combinations of measures were discarded at an earlier stage.

Next to the stakeholder support for building upon the Euro 6/VI emission standards with PO1 to PO3, one could also think of solving the problems discussed in chapter 2 through voluntary measures, especially considering that many technologies for further reducing vehicle emissions are already available on the market. Nevertheless, their adoption is not likely to happen using voluntary measures, as was already shown by the scarce propensity of the industry to introduce any additional measures linked with emissions. This was demonstrated clearly in the antitrust case of the Commission against three major car manufacturers for restricting competition in emission after treatment systems for new diesel cars.[142] In particular, the manufacturers did not use better available technology (AdBlue tanks), as this was not explicitly required by the type-approval legislation. As discussed in section 2.3, this follows from the fact that emission control technologies do result in costs and subsequently higher vehicle prices, while perceived value of improved pollutant emissions performance by customers is often limited.

6 WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

The quantification of the impacts of the three policy options, for the cars/vans as well as the lorries/buses segments, relies on a number of models which use input of regulatory costs and the emissions reduction performance of available or future technologies necessary to comply with the different policy options. The models used, i.e. COPERT

[141] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 4.3 Description of the policy options.

[142] European Commission, 2021. Press release: Antitrust: Commission fines car manufacturers €875 million for restricting competition in emission cleaning for new diesel passenger cars

and SIBYL, are amongst the most advanced in the field and are used widely both in Europe and around the world for the estimation of emissions from road transport. They are at the basis of the national and EU submission of emission inventories to Intergovernmental Panel on Climate Change (IPCC) and have been developed over the years with input from numerous projects. A network of experts from 57 leading EU institutions has been directing their development in Europe for the past decades[143].

Such detailed models are needed in order to provide adequate detail both on the technological choices, mileage covered, vehicle age and other details which are crucial for estimating the emissions from the European fleet now and in the future. Models often used for other impact assessments assessing the fleet level (e.g. PRIMES, GAINS etc.) are less suitable for detailed modelling at vehicle level required for estimating the effects of changes in the type-approval legislation. Detailed information on the methodological approach can be found in Annex 4.

Industry strongly opposes disproportionate burden which may eventually trigger a decision to stop ICE production. They support in-between PO1 and PO2a solution. On the other hand, there is a pressure from environmental and consumer organisations and some Member States to set more ambitious requirements as in PO3a and PO2b to support further improvement in air quality and thus contribute to protecting public health and the environment, while it may be expected that such digital solution as proposed in PO3a may raise concerns of social acceptability of continuous monitoring. However, such potential concern of making pollutant data from vehicles available was not raised by consumer organisations or citizens in the stakeholder consultations.

The aforementioned stakeholders were encouraged to verify or contest any result or assumptions in the extensive public and targeted stakeholder consultations, including interviews and confidential data sharing, and various AGVES meetings (see Annex 2). In total, more than 200 experts were participating in each meeting. Feedback and differences in stakeholders' views received through these channels were carefully analysed and taken into account. **In the assessment of the impacts of the policy options, in particular on industry competitiveness, consumer affordability and employment, qualitative stakeholder data has been triangulated with quantitative estimates and/or literary evidence depending on the specific impact** (see each section below). A detailed overview of the stakeholder views and the use of the consultation results is included in Annex 2.

To ensure **robustness of the analysis**, the estimated impacts and their underlying assumptions have been cross-checked with independent experts and the concerned stakeholders, separately for the cars/vans and the lorries/buses segments. To address any remaining uncertainty, the level of confidence for each regulatory cost category and the health and environmental benefits was assessed. Based on the availability and quality of information, data and shared input by stakeholders, the administrative costs and costs during implementation phase (including testing and witnessing cost and type-approval fees) are characterised by a high level of confidence, the equipment costs by medium (R&D and related calibration costs) or medium-high (hardware costs for emission control technology) confidence. Medium-high confidence is also assumed for the health and environmental benefits that are calculated based on the models above and the

[143] See Leading EU Models | ERMES GROUP (ermes-group.eu)

Commission’s Handbook on the external costs of transport.[144] This medium to high level of confidence of the cost and benefit estimates valid for the cars/vans as well as the lorries/buses segments and verified by stakeholders and experts is considered sufficiently robust to present in chapter 6 average values for the cost and benefit elements. Nevertheless, the cost-benefit analysis in chapter 7 is complemented by providing ranges of expected costs and benefits, separately for the cars/vans and the lorries/buses segments, to make political choices based on the net benefits of the policy options. More information can be found in Annex 4 section 1.3.2.1. Uncertainty.

6.1 PO1: Low Green Ambition

6.1.1 Economic impacts

6.1.1.1 Regulatory costs for automotive industry

The regulatory costs for automotive industry consist of substantive compliance costs (equipment costs for emission control technologies and the related R&D and calibration costs including facilities and tooling costs as well as costs during implementation phase for testing, witnessing of tests by type-approval authorities and type-approval fees) and administrative costs (reporting and other information obligations as part of the type-approval procedures). A detailed description of the cost categories is available in Annex 5, Table 39.

The simplification measures introduced in PO1 aim at reducing complexity, eliminating inconsistencies and improving effectiveness of the legislation. This policy option is expected to result in some cost reductions, especially of costs during implementation phase and administrative costs, largely due to the streamlined testing procedures or removal of obsolete ones. However, these cost savings would be offset by the expected increase in R&D, hardware and related calibration costs linked with technology-neutral limits and extended real-driving testing for all vehicle categories except for petrol/compressed natural gas (CNG) lorries/buses. For these vehicles, a small total regulatory cost saving of €2 per vehicle is expected. For diesel lorries/buses, the implementation of the simplification measures are expected to reduce costs during the implementation phase and administrative costs by €49 per vehicle. However, such cost savings would be offset by an increase in R&D and related calibration costs of €103 per vehicle. The total regulatory cost for lorries/buses are estimated at €44 per vehicle.[145]

Also for cars/vans, no total regulatory cost savings are expected. While cost savings during implementation phase and administrative cost savings are expected with the simplification measures, these will likely be exceeded by hardware, R&D and related calibration costs. The largest share of the latter costs follow from the need to ensure that emission are also controlled in enhanced real-driving testing outside the current RDE boundaries, while a smaller share is linked to introducing technology-neutral limits. In all, the total regulatory cost for cars/vans for industry are estimated at €60 per vehicle.

[144] European Commission, 2019. Handbook on the external costs of transport
[145] The cost per vehicle is calculated by dividing the regulatory cost over the period 2025-2050 by the total number of vehicles per vehicle category. This total cost is calculated by adding up all the different cost categories (which include one-off and recurrent costs) (see Annex 5 Table 39) over their specific unit. These units do not only include the number of new vehicle registrations per category, but also the number of engine/model families, type-approvals, manufacturers and calibrations. Hence, the cost per vehicle and regulatory cost is affected by changes in the fleet and in the specific unit.

To ensure that no administrative burden is added, administrative costs[146] are assessed separately. Euro emission standards trigger recurrent administrative costs, including costs for reporting and compliance with other relevant information obligations as part of the process for granting type-approval, Conformity of Production (CoP) and In-Service Conformity (ISC).[147]

Since PO1 allows for reduction of the number of type-approvals and tests with reporting requirements, the simplification measures translate into significant administrative cost savings in all vehicle categories. For cars/vans, administrative cost savings are estimated at €97 thousand per type approval for petrol cars/vans (€18 per vehicle) and at €126 thousand per type approval for diesel cars/vans (€17 per vehicle). For lorries/buses, savings of €30 thousand are expected per diesel type-approval (€14 per vehicle) and of €31 thousand per petrol type-approval (€31 per vehicle).

A detailed description of the total regulatory costs for automotive industry in PO1 compared to the baseline is available in Annex 4, section 1.3.1.1.

Table 3 presents the total regulatory costs in 5-year intervals over the period of implementation of PO1. It shows that the largest share of the costs occur in the first five years after 2025. Since PO1 does only introduce changes in the requirements and emission testing for combustion-engine vehicles, the regulatory costs become zero after the proposed end-date of combustion-engine cars and vans in 2035.

Table 3 – Expected distribution of total regulatory costs in PO1 compared to the baseline, in billion € and 2025 NPV[148]

	2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	Total
Cars and vans	2.00	2.51	0.53	0.00	0.00	0.00	5.04
Lorries and buses	0.38	0.10	-0.09	-0.06	-0.04	-0.03	0.27

These costs consist of both recurrent costs (e.g. for hardware) – that increase with the number of produced vehicles or type-approvals – and one-off costs (e.g. related to the development of new emission control systems) that are expected to be similar for the manufacturers, irrespective of size.[149] Taking into account the market share of car/van manufacturers in the EU[150], the two largest manufacturing groups[151], which together had 46% of the car market in 2019, would have to invest a maximum of €0.7 billion each for the whole period 2025-2035. For all other car/van manufacturers, PO1 would only

[146] Administrative costs are those costs incurred by stakeholders to comply with information obligations, such as reporting or registration and include requirements for information documents, type-approval certificates, result sheet, test reports, certificates of conformity and vehicle registration.
[147] Commission Implementing Regulation (EU) 2020/683 implementing Regulation (EU) 2018/858 with regards to the administrative requirements for the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles
[148] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 5.1.2. Economic impacts, Policy Option 1.
149 CLOVE, 2022. Euro 6/VI Evaluation Study. ISBN 978-92-76-56398-3, chapter 5.2 Efficiency, evaluation question 4; CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 5.1.3.; 5.2.3.; 5.3.3. Cost-benefit analysis.
[150] Car Sales Statistics, 2020. 2019 Europe: Best-Selling Car Manufacturers and Brands (based on ACEA)
[151] Volkswagen Group and Stellantis Group (formed in 2021 through a merger between Fiat Chrysler Automobiles and PSA)

require a total investment between €0.2 and €0.3 billion for the same period. The total regulatory costs for the industry divided by the 12 main manufacturers of lorries/buses mean that each lorries/buses manufacturer would have to invest €0.02 billion. This a very small additional amount to the €59 billion each car manufacturer is estimated to invest for the shift to automation, connectivity and electrification.[152]

With the end-date of combustion-engine cars/vans by 2035, the cumulative annual investment of PO1 and proposed CO_2 emission standards for cars/vans[32,153,32] over 2021-2040 amounts to €19.2 billion, out of which €19 billion is due to the proposed CO_2 target and €0.2 billion due to PO1 (see Annex 4, Table 33). Hence, the investment attributable to PO1 is with 1% increase in annual investments not high. See detailed analysis on the cumulative impacts on industry in Annex 4 section 1.5.4.

Table 5 (II.A) in Annex 3 presents an overview of these regulatory costs for manufacturers split up in one-off and recurrent costs linked to the different policy measures, including simplification measures and technology-neutral limits and extended real-driving conditions.

6.1.1.2 Competitiveness

The views of **stakeholders from industry, civil society and Member States** on competitiveness were collected as part of the targeted stakeholder consultation. No specific views were expressed regarding PO1.

While the European automotive industry is considered to hold a strong position in international trade, in recent years Europe has been overshadowed by other emerging markets. In 2019, about 20% of motor vehicles produced globally was produced in Europe[154], in comparison with 32% in the year 2000[155]. The positive trade balance of EU cars have continued to decrease since 2015 with imports rising while exports of EU cars remained more stable.[156] In 2018, EU exports of cars to main trade partners the United States and China still amounted up to €37 and €22 billion, in comparison to imports worth €6 and €0.5 billion respectively.[157] A detailed description of EU export of motor vehicles to key destinations is available in Annex 4, section 1.4.1., for EU-27 passenger car exports as well as EU-27 motor vehicles (i.e. cars, vans, lorries and buses).

The evaluation of the Euro 6/VI showed that global pressure to reduce transport emissions intensifies, not least because other key players, in particular China and the United States, have introduced or are planning to introduce more demanding vehicle

[152] McKinsey Center for Future Mobility, 2020. Estimation of the level of investment from car manufacturers to gain a defensible position in new technologies

[153] Since the recently proposed CO_2 emission standards only have implications for cars and vans and a revision of the CO_2 emission standards for heavy-duty vehicles is only planned for 2022, the cumulative impact assessment focuses only on the cumulative impacts in the cars and vans segments. The scenario TL_High in the CO_2 impact assessment, which is the closest scenario to the final adopted CO_2 proposal, was used to calculate the cumulative impacts.

[154] ACEA, 2021. Production

[155] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 5.2.2. Economic impacts.

[156] Eurostat, 2020. International trade in cars.

[157] ACEA, 2019. EU-US automobile trade: facts and figures; ACEA, 2019. EU-China automobile trade: facts and figures

emission standards.[44] Despite the fact that the Euro 6/VI legislation have set the stage for real-driving testing worldwide, today EU is found to be lagging behind when it comes to i.a. pollutants coverage and emission limits.[158]

Nevertheless, PO1 is only expected to have a very limited effect in aligning the EU with emission regulatory developments in the United States and China. Only the extended RDE testing is expected to slightly improve the EU's competitive position in real-driving testing. PO1 is not expected to change the **access to international markets** of EU's automotive industry, given that other countries develop more ambitious emission standards.

PO1 requires almost no R&D efforts for development of emission control systems, neither for the cars/vans nor for the lorries/buses segments. Therefore, **innovation** of European companies in the supply-chain will not be encouraged nor will their competitive position improve in comparison to what is expected in the baseline. In all, positive effects on the mobility ecosystem as a whole are expected to be limited.[159]

The assessment of access to international key markets, innovation and cumulative investments with CO_2 emission standards (see 6.1.1.1) leads to the conclusion that no impacts are expected from PO1 on industry competitiveness.

6.1.1.3 Single market

PO1 is expected not to affect the intentions of Member States with regard to national initiatives aiming at tackling significant pollutant emission from road transport, such as bans for diesel or all combustion engines and the introduction of zero-emission zones (see chapter 2), putting at risk the functioning of the single market.

6.1.1.4 SMEs

The European automotive industry mostly comprises of large manufacturers active in vehicle assembly and component production. However, SMEs are present among the suppliers of equipment. They may be indirectly affected by newly required emission control technologies or other equipment.

Some SMEs manufacture vehicles or systems that require an EU emission type-approval. 35 SMEs[160] were identified in the cars/vans segment[161], which are mostly small companies (i.e. staff headcount < 50 and either turnover or balance sheet total ≤ €10m). These 35 SMEs are building specialised vehicles on the basis of powertrains produced by larger manufacturers[162]. Nevertheless, these SMEs rarely carry out calibration of the specific powertrains in order to make them comply with new emission standards. Since no significant changes to the emission control technologies and calibration of engines are expected in PO1, the impact on SME manufacturers is expected to be negligible.

---

[158] CLOVE, 2022. Technical studies for the development of Euro 7. Testing, Pollutants and Emission Limits. ISBN 978-92-76-56406-5, chapter 3.2 Emission standards outside of the EU.

[159] Industrial ecosystems encompass all players operating in a value chain: from the smallest start-ups to the largest companies, from academia to research, service providers to suppliers. For more information see footnote 16 (industrial strategy).

[160] SME definition (europa.eu)

[161] No SMEs were identified in the lorries/bus segment.

[162] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 5.1.2 Economic impacts.

A higher number of SMEs is expected to be indirectly affected by new vehicle emission standards as users (e.g. transport or logistics services, vehicle rental or leasing companies, companies using vehicles) due to price and affordability of light- or heavy duty vehicles. Assuming that costs translate into vehicle prices as demonstrated in the Euro 6/VI evaluation[76], the total regulatory costs in PO1 are expected to be less than 0.5% of the estimated light- or heavy-duty vehicle price (see Annex 4, Table 17). Hence, only negligible impact is expected on the affordability of vehicles by SME users in comparison to the baseline.

6.1.2 Environmental impacts

Air pollutant emission reductions are expected to increase with time even with Euro 6/VI vehicle fleet renewal in combination with the impact of the new CO_2 standards (see chapter 5.1).

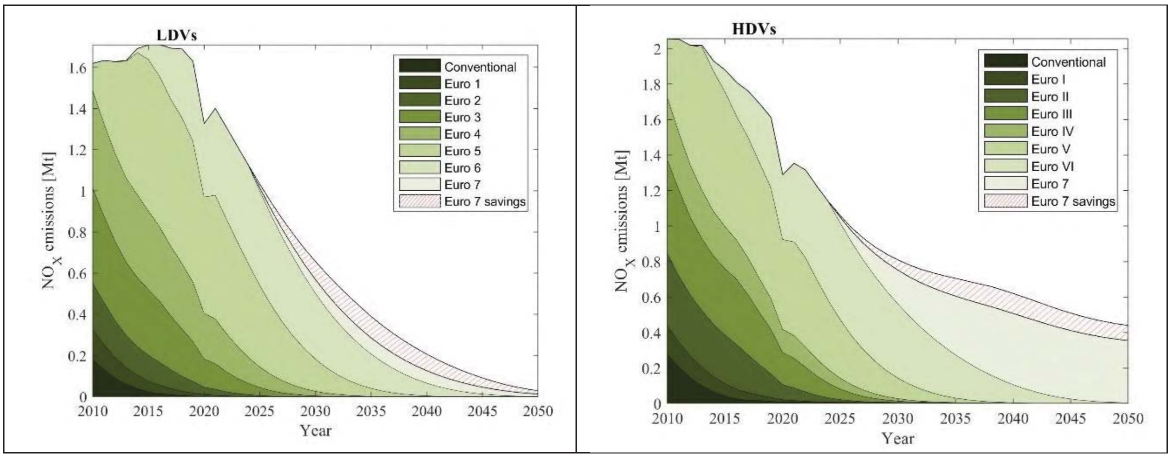
As illustrated for key pollutant NO_x in Figure 8 and all pollutants in Annex 4, Table 11, the emission reductions that can be expected in PO1 are rather limited. This is due to maintaining the current emission limits (only ensuring technology neutrality). Broader RDE testing conditions and improved OBD allowing for more effective ISC and MaS over the lifetime of vehicles do not change this conclusion.

For cars/vans, NO_x emissions are expected to further decrease by 13% in 2030 to 55% in 2050, compared to the baseline. This significant decrease follows from the introduction of low ambition extended real-driving testing covering conditions outside the current RDE boundaries and a technology-neutral NO_x emission limit. Some reductions can be expected for particles, NH_3 and CO emissions from cars/vans compared to the baseline.

For lorries/buses, NO_x emission reductions are the only reductions expected in PO1. The Euro VI limits are already technology-neutral. The reduction of NO_x emission, 7% in 2030 to 19% in 2050, derive from extended real-driving testing covering conditions outside the current PEMS boundaries and assumed increased frequency of ISC and MaS testing.[163]

Figure 8 – NO_x reductions from light- and heavy-duty vehicles in PO1 compared to the baseline, Source: SIBYL/COPERT 2021

[163] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 5.1.1 Environmental impacts



6.1.3 Social impacts

6.1.3.1 Monetised health and environmental benefits

By reducing harmful pollutants, a new vehicle emissions standard benefits citizens by curbing negative health impacts from road transport that cause respiratory and cardiovascular diseases upon inhalation e.g. bronchitis, asthma or lung cancer. This health benefit can be monetised using the concept of external costs developed for the Commission's Handbook on the external costs of transport. It reflects the damage costs by air pollution from transport to health and environment. While benefits of reducing emission are independent of the absolute emission levels, the differences in exposure for metropolitan, urban and rural areas are taken into account. Combatting health impacts is expected to result in a reduction of medical treatment costs, productivity losses due to illnesses and even deaths.[164][165]

Although the damage costs by air pollution from transport take into account predominantly the impact on health, they also reflect impact on the environment such as crop losses, material and building damage and biodiversity loss due to particulate matter formation, photochemical oxidant formation, acidification, eutrophication and ecotoxicity of air, water and soil (see Annex 4, Box 3 and Figure 10 and 11). Hence, Table 4, in which the monetised health and environmental benefits are presented, also reflects all relevant environmental Sustainable Development Goals (SDGs)[166] of the 2030 UN Agenda for Sustainable Development. With monetary benefits estimated for these parameters in all policy options (see 6.2.3 and 6.3.3), PO1, 2 and 3 are not expected to do significant harm to any of the environmental SDGs.

Table 4 shows the monetised health and environmental benefits in PO1 compared to the baseline. Since PO1 considers technology-neutral emission limits and some improvements regarding extended real-driving testing, benefits are only expected to be achieved through reductions of NO_x, exhaust PM and NH_3 emissions. Through the reduction of NO_x emissions from cars/vans, PO1 is expected to result in a €20.6 billion reduction of external costs up to 2050. With a total reduction of €21.1 billion for lorries/buses, reduction of NO_x emissions from these vehicles is expected to have a

[164] European Commission, 2019. Handbook on the external costs of transport, Version 2019 -1.1
[165] See Annex 4: Analytical methods, section 1.2.3 Damage costs
[166] Goal 3: Good health and well-being, Goal 6: Clean water and sanitation, Goal 13: Climate action, Goal 14: Life below water and Goal 15: Life on land from United Nations, 2021. The 17 Goals

slightly larger benefit. Additional health and environmental benefits are expected from the reduction of the particle number threshold from 23 nm to 10 nm in PO1. Lastly, the emission reductions for NH_3 for cars/vans are expected to result in benefits up to €0.9 billion.

Table 4 – Monetised health and environmental benefits for PO1 compared to the baseline, Source: SIBYL/COPERT 2021

	Monetised health and environmental benefits until 2050 (billion €)				
	NO_x	$PM_{exhaust}$	$PM_{non\text{-}exhaust}$	NH_3	NMHC
Cars and vans	20.63	0.33	0.00	0.94	0.01
Lorries and buses	21.14	0.00	0.00	0.00	0.00

6.1.3.2 Employment and skills

The Euro 6/VI evaluation found no compelling evidence that emission regulations have a negative effect on employment. On the other hand, Euro 6/VI may positively impact employment through creation of new jobs in R&D domain or those related to production of emission control systems at the suppliers.[44]

Almost half of the **suppliers** in the targeted consultation stressed that new limits will create new business opportunities and quality jobs. Since PO1 only aligns the emission limits for different vehicle technologies, no impact on employment is expected in PO1, neither in the cars/vans nor the lorries/buses segments. Reason for this being that there is no need for new workforce for the continued use of current emission control technologies or to control emission outside the current RDE boundaries.

Nevertheless, resources for type-approval and testing services may slightly decrease following the introduction of simplification measures and the expected lower number of emission type-approvals in PO1, and subsequently also policy options 2 and 3.

Since PO1 does not require new emission control or ICT technologies, no up- or re-skilling should be needed compared to the baseline.

6.1.3.3 Consumer affordability

It is expected that total regulatory costs following new policy measures for vehicles initially borne by manufacturers are eventually passed on to the consumers, at least in the longer term. It is difficult to establish a clear correlation between regulatory costs and vehicle prices.[167] The Euro 6/VI evaluation could not demonstrate if a price increase of cars since 2014 is associated with regulatory costs stemming from the Euro 6/VI, since the observed increase could also result from other factors affecting prices, e.g. installation of comfort equipment or changes in fleet composition towards more heavy and expensive vehicles.[44] However, 121 out of 139 respondents to the public consultation from **all stakeholder groups, including citizens**, considered that Euro 6/VI has led to an increase in the prices of cars, vans, lorries and buses.[168] The regulatory cost increase could lead in the most relevant segment for low income consumers, i.e. small cars/vans, to 0.1% vehicle price increase for petrol vehicles and 0.5% for diesel vehicles, which is

[167] Mamakos, A. et al., 2013. Cost effectiveness of particulate filter installation on Direct Injection Gasoline vehicles

[168] European Commission, 2020. Presentation AGVES Meeting 26 November 2020: Post-Euro 6/VI public stakeholders consultation (Question 3.1)

considered not significant. See detailed comparison of total regulatory costs per vehicle segment in Annex 4, Table 17.

Private users are not considered relevant for heavy-duty vehicles. The impact on SME users of heavy-duty vehicles are discussed in section 6.1.1.4.

While Euro emission standards are expected to increase costs for consumers, the newly proposed CO_2 emission standards for cars/vans[32] are expected to decrease the total cost of ownership (TCO)-first user[169] of new cars/vans. This is explained by the fuel and electricity savings that are expected to outweigh the high upfront costs of zero- and low-emission vehicles. In 2030, PO1 is estimated to slightly decrease the net saving in TCO of €600 per vehicle achieved through the proposed CO_2 targets by €13 for cars and by €74 for vans. Overall, the net savings in the TCO are still found to be highly positive. See detailed analysis on the cumulative impacts on consumers in Annex 4 section 1.5.2.

6.1.3.4 Consumer trust

While consumer trust was severely affected by Dieselgate in 2015, the last Euro 6d step for cars/vans introducing RDE testing and the changes to the EU type-approval rules with strengthened and independent testing, market surveillance and new enforcement procedures had positive impact on consumer trust[170]. PO1 is expected to have low positive impact on consumer trust. Some positive impact is expected due to introduction of technology-neutral limits, while real-driving testing is slightly enhanced in PO1.

6.2 PO2: Medium and High Green Ambition

6.2.1 Economic impacts

6.2.1.1 Regulatory costs for automotive industry

The total regulatory costs are expected to be higher in PO2 in order to meet medium ambitious emission limits and testing boundaries of PO2a and high ambitious emission limits and testing boundaries of PO2b, compared to PO1. The increase of hardware costs, caused by the new emission control technologies available in the market today, and of some R&D costs for technology system integration and calibration, raises the total regulatory cost compared to the baseline for all vehicle categories. Total regulatory costs per vehicle are higher for lorries/buses than for cars/vans due to the more robust emission control systems required for such vehicles.

While the simplification measures lead to cost savings during the implementation phase and administrative cost savings (€41 per vehicle), the new requirements for tailpipe, evaporative and brake emission are expected to result in additional R&D, hardware and calibration costs. The hardware cost per vehicle are calculated using the cost of different technology packages weighted over the development of the fleet in the assessed period. The different technology packages to achieve the requirements of PO2a and PO2b and their costs were verified by **stakeholders from automotive industry, civil society and**

[169] While the CO_2 impact assessment also inspects the impacts on the total cost of ownership from the second user perspective, for this assessment an analysis of the first user perspective is deemed sufficient. The Euro emission standards mostly affect consumer affordability and the cost of ownership through the impact on the price of vehicles for first users. Impacts on the second users market will be limited since the increase is expected to be only a fraction of the price for first users, for all options.

[170] See Annex 2: Stakeholder consultation, 2.2.1 Evaluation Euro 6/VI emission standards

some Member States and are presented in Table 21 in Annex 4.

For diesel cars and vans, in PO2a regulatory costs linked to the requirements for tailpipe and evaporative emissions are estimated at €399 per vehicle and in PO2b at €463 euro per vehicle. For petrol cars and vans, these costs are expected to be lower estimated at €144 per vehicle in PO2a and at €327 per vehicle in PO2b. In addition, the introduced limits for brake emissions lead to additional hardware costs that differ between combustion-engine and electric vehicles due to differences in technologies and braking patterns. For combustion-engine cars and vans, in PO2a additional regulatory costs linked to the requirements for brake emissions are estimated at €23 per vehicle and in PO2b at €100 per vehicle. For electric cars and vans, these additional regulatory costs are estimated at €13 per vehicle in PO2a and at €60 per vehicle in PO2b.

Overall, this would result in total regulatory costs for cars/vans of €297 per vehicle in PO2a and of €475 per vehicle in PO2b.[144171] This cost estimate for cars/vans in PO2a is below the total regulatory costs associated with introduction of Euro 6 for diesel cars/vans, but exceeds the total regulatory costs associated with the introduction of Euro 6 for petrol cars/vans. In case of PO2b, the total regulatory costs per vehicle for cars/vans are in the range of the total regulatory costs of Euro 6 for diesel cars/vans.[172]

For lorries/buses (mainly diesel), in PO2a the cost per vehicle is estimated to increase by €2 601 and in PO2b this cost is estimated to increase by €4 059 for internal combustion engine vehicles. Similar to PO1, the cost savings following the simplification measures (€60 per vehicle) are expected to be exceeded by the hardware, R&D and calibration costs linked to the new limits, testing and durability requirements (€2 661 per vehicle in 2a and €4 119 per vehicle in 2b). For these vehicles, the total regulatory costs are found below the total regulatory costs of the introduction of Euro 6/VI for PO2a and in the range for PO2b.[171]

Following the same reasoning as in PO1, PO2 is also expected to result in savings in administrative costs. Since PO2 includes the simplification measures introduced in PO1, the administrative costs savings are estimated at the same levels.

A detailed description of the total regulatory costs for automotive industry in PO2 compared to the baseline is available in Annex 4, section 1.3.1.2.

Table 5 presents the total regulatory costs in 5-year intervals over the period of implementation of stricter emission limits in PO2, including tailpipe, evaporative and brake emissions. It shows that the largest share of the costs occur in the first ten years after 2025. Subsequently, the costs will decrease with a **small share of the costs remaining after 2035**, mainly resulting from the **requirements regarding brake emissions for all cars/vans, including zero-emission vehicles**, and combustion-engine lorries/buses. They will also be due to the need to continue market surveillance and in-service conformity checks throughout the lifetime of vehicles (i.e. at least for another 10-15 years after the first registration). For all categories, the five year costs decrease over

[171] For cars/vans, this cost per vehicle in PO2a corresponds to €280 per ICE vehicle for costs linked to requirements for tailpipe and evaporative emissions and €17 per vehicle for all powertrains linked to requirements for brake emissions. For cars/vans in PO2b, this is €399 per ICE vehicle and €76 per vehicle for all powertrains.

[172] See Annex 5: Evaluation Euro 6/VI emission standards, chapter 6 Conclusions: For Euro 6 cars/vans, the total regulatory cost for the period up to 2020 increased by €357-€929 per CI vehicle and €80-€181 per PI vehicle. For Euro VI lorries/buses, the total regulatory costs increased by €3 717-€4 326 per vehicle.

time as a consequence of the decreasing number of combustion engine vehicles.

Table 5 – Expected distribution of total regulatory costs in PO2 compared to the baseline, in billion € and 2025 NPV

	2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	Total
PO2a – Medium Green Ambition							
Cars and vans	8.62	14.77	4.26	1.03	0.86	0.72	30.27
Lorries and buses	5.72	5.82	2.22	1.35	0.76	0.57	16.44
PO2b – High Green Ambition							
Cars and vans	12.99	28.62	10.33	4.70	3.93	3.27	63.84
Lorries and buses	6.50	9.07	4.57	2.78	1.56	1.17	25.65

Taking into account the market share of car/van manufacturers in the EU[149], the two largest manufacturing groups, would have to invest between €5.1 and €5.7 billion each in PO2a and between €12 and €13.6 billion in PO2b for the whole period between 2025 and 2050, i.e. over 25 years. For all other car/van manufacturers, PO2a would only require a total investment between €0.5 and €2.7 billion, while PO2b would require a total investment between €0.5 and €6.1 billion for the same period depending on the size of the manufacturer. The investment costs for PO2a can be translated €1.4 billion per manufacturer of lorries/buses while for option 2b the costs increase to €2.1 billion respectively. This is still expected to have a low impact on the estimated investment need for car makers of €59 billion to address automation, connectivity and electrification challenges[151], costs are still considered low for the automotive industry in particular those for PO2a.

Especially **automotive industry** has raised concerns regarding too high cumulative impacts in view of the CO_2 investments and the technological potential for reducing emissions. With the end-date of combustion-engine cars/vans by 2035, the cumulative annual investment of PO2a/PO2b and proposed CO_2 emission standards[32] over 2021-2040 amounts to €20.2/€21.4 billion, out of which €19 billion is due to the proposed CO_2 target and €1.2/€2.4 billion due to PO2a/PO2b (see Annex 4, Table 33). The investment attributable to PO2a is considered with 7% increase in annual investments not too high, while the investment attributable to PO2b is considered with 13% high. See detailed analysis on the cumulative impacts on industry in Annex 4 section 1.5.4.

Table 5 (II.B) in Annex 3 presents an overview of these total regulatory costs for manufacturers split up in one-off and recurrent costs linked to the different policy measures, including simplification measures, medium and high ambition emission limits, real-driving testing boundaries and durability.

6.2.1.2 Competitiveness

The views of stakeholders on competitiveness were collected as part of the targeted stakeholder consultation. While **Member States and civil society** generally expect a positive relationship between stricter standards and competitiveness, differing views were found amongst **industry stakeholders** with suppliers anticipating positive impacts and manufacturers negative impacts (see Annex 2, Figure 7). Stakeholders did not express different views on the cars/vans and lorries/buses segments.

Through the Euro standards, the EU has traditionally been the global emission standard setter, and the EU automotive industry has traditionally been the technological leader for internal combustion engines. PO2 would put the EU in the forefront of vehicle emission reductions worldwide, overtaking the actual regulatory developments in other key market such as China and the US for tailpipe pollutants except durability (see 6.1.1.2) as well as for new ones that will be there irrespectively of the engine: from brakes and, in the future, from tyres. This would maintain **access to international markets**.

In addition, over recent years EU export of cars has followed a downwards trend, while import has known a steady increase. In 2019, car exports amounted up to €140 billion, while imports to €63 billion.[155] This downward trend is also visible for the export of all motor vehicles, including all light-duty as well as heavy-duty vehicles. In 2019, EU exports of motor vehicles added up to €157 billion and imports to €71 billion.[173] The stricter emission limits for internal combustion engines in PO2 should support EU automotive industry to seize opportunities for further cleaning of internal combustion engines that will still play a role in several third markets for which a slower transition to zero-emission cars/vans is expected, such as in India, South-East Asia, Brazil or South Africa, and in the lorries/buses segment[174]. Choice of PO2 is expected to increase export of EU goods compared to the baseline values, reversing current trends, thus positively affecting the global market share of the EU.[154]

These findings for PO2 are also supported by the majority of component suppliers participating in the targeted consultation, indicating that new emission limits will encourage **innovation** in the supply-chain and increase the competitiveness of the EU automotive industry on the global stage. Vehicle manufacturers, on the other hand, tend to be more reserved on this point.[175] For the whole mobility ecosystem the effects of PO2 are expected to be positive, given the strong competitive position of EU suppliers of emission control systems.

Despite the total regulatory costs for industry and cumulative investments with CO_2 emission standards for cars/vans (see 6.2.1.1), PO2a and PO2b are expected to have a low to moderate positive effect on competitiveness in terms of access to international markets and innovation. Stimulating innovation in zero-emission technologies by CO_2 emission standards as well as in pollutant emission control technology, access to international markets can be maintained while improving the competitive position of the EU automotive sector over the baseline.

However, the assessment also shows that some of the concerns of **automotive industry** regarding stricter Euro emission standards are justified, such as high investments in the cars/vans segment with emission limits lower than 30 mg/km for NO_x and high ambitious real-world testing in all driving conditions in PO2b.

---

[173] ACEA, 2022. EU motor vehicle exports, main destinations (by value). ACEA, 2022. EU motor vehicle imports, main countries of origin (by value).
[174] Zhao, Fuquan et al, 2020. Challenges, Potential and Opportunities for Internal Combustion Engines in China
[175] See Annex 2: Stakeholder consultation, section 2.2.6. Impacts of a stricter emission standard

6.2.1.3 Single market

It is expected that PO2 will increase confidence in vehicles, in particular cars, being clean in all conditions of use and may encourage Member States to reconsider announcements for vehicle bans and local or regional vehicle access limitations, in particular as those have to be notified as potential barriers of internal EU trade of vehicles under Directive 2015/1535[176]. PO2, by increasing confidence in clean vehicles under extended conditions of use and subsequently making Member States reconsider need for unilateral measures, positively affects the functioning of the single market through setting more adequate, future proof rules for vehicles emission. Higher positive impact is expected in PO2b than in PO2a as the former introduces high ambition emission limits and testing boundaries.

6.2.1.4 SMEs

The new requirements considered in PO2 could potentially be more difficult and costly to implement for the 35 SME cars/vans manufacturers[177] (see 6.1.1.4). Most of those SMEs are specialised in sporty and lightweight cars that are predominantly equipped with petrol engines, whose emission control systems present the lowest total regulatory costs in the vehicle categories. Furthermore, several of these SMEs are supported by the research facilities of larger manufacturers to whom they are linked in the supply chain. In the targeted stakeholder consultation, differing views on the effect of PO2 on SME manufacturers were found. While **large manufacturers** were pessimistic, **suppliers** were uncertain or slightly positive considering that SMEs would not be significantly affected in a positive or negative manner by the proposed measures in PO2.[174]

The SME users of motor vehicles, such as transport services, etc., are mostly concerned about the effect of new requirements on the price and affordability of vehicles. When fully passed on to SME users, the total regulatory costs in PO2a amount up to 2.1% for small cars/vans and up to 3.1% for small lorries of the vehicle price, and in PO2b up to 2.8% for small cars/vans and up to 4.9% for small lorries (see Annex 4, Table 22). Hence, the strictest emission limits are expected to have medium negative impact on the affordability for SME users.

6.2.2 Environmental impacts

As illustrated for key pollutant NO_x in Figure 9 and all pollutants in Annex 4, Table 12, the emission reductions compared to the baseline that can be expected by introducing strict emission limits (PO2a) are significant, in particular for lorries/buses. The reduction of emissions for cars/vans is also important, as those vehicles are predominantly used in densely populated urban areas where more citizens are exposed.

For cars/vans, NO_x emission are expected to decrease significantly and rapidly compared to the baseline, by 21% in 2030, 42% in 2035, 62% in 2040 to 88% in 2050. This significant reduction follows from the introduction of medium ambition extended real-driving testing covering almost all conditions outside the current RDE boundaries and a

[176] Directive (EU) 2015/1535 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services; see also 2015/1535 notification procedure

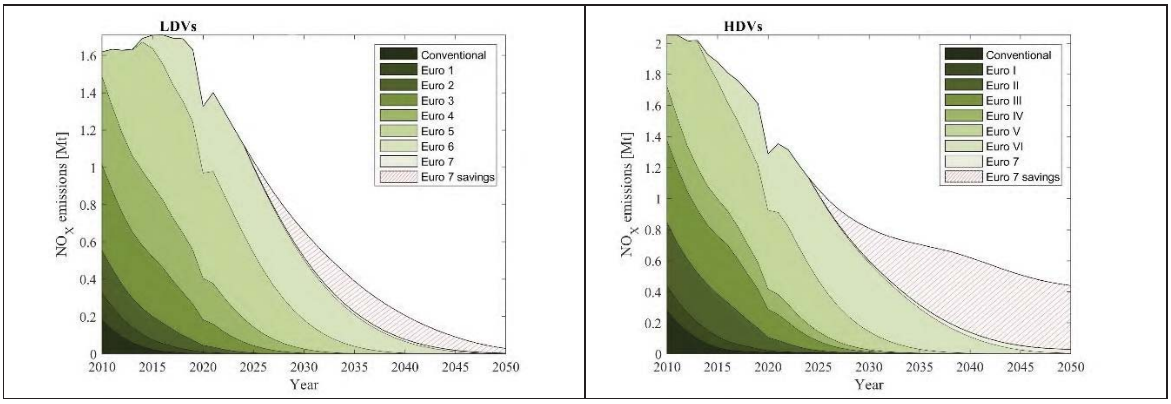
[177] No SMEs were identified in the lorries/bus segment.

technology-neutral NO_x emission limit of 30 mg/km for cars. This replaces the diverging NO_x limits of Euro 6 of 60 mg/km for petrol cars and 80 mg/km for diesel cars. The decrease in Figure 9 illustrates that cars/vans progress more rapidly toward zero-pollution levels (about 0.08 Mt NO_x/a) in 2040, compared to similar levels reached in 2050 in the baseline.

Additional significant reductions can also be expected due to the stricter air pollutant emission limits and increased durability requirements (see details in Annex 4, section 1.2.3.2). Brake emissions, an example for stricter emission limits, have become increasingly relevant sources of non-exhaust particles and are assumed to go down by 16% in 2030 to 36% in 2050 through the use of improved brake pads[178].

For lorries/buses, the highest emission reductions can be expected under PO2a due to the more stringent air pollutant emission limits for NO_x, particles, hydrocarbons, CO, NH_3 and N_2O emission. NO_x emission are assumed to decrease by 0.2 Mt in 2030 to 0.4 Mt in 2050. This high reduction comes from the fact that in the EU fleet a significant number of HDVs, in particular diesel lorries, is still expected to be equipped with a combustion engine vehicle until 2050 (see Figure 7).

Figure 9 – NO_x reductions from light- and heavy-duty vehicles in PO2a compared to the baseline, Source: SIBYL/COPERT 2021



As illustrated for key pollutant NO_x in Figure 10 and for all pollutants in Annex 4, Table 13, the emission reductions compared to the baseline that can be expected by PO2b are significant, in particular for lorries/buses. However, PO2b is expected to lead only to marginal additional emission reductions compared to PO2a for all categories of vehicles (compare Figure 9 and Figure 10).

For cars/vans, the small difference in emission savings between PO2a and PO2b is explained by the small emissions levels. The only major difference are emissions during cold start, which are more effectively controlled under the stricter emission limits under PO2b, rather than under the medium ones in PO2a.

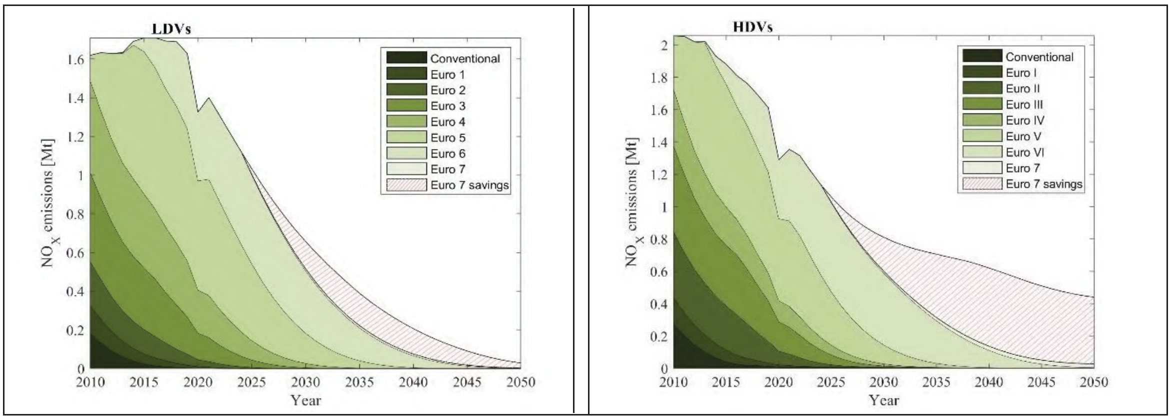
For lorries/buses, the marginal NO_x effect is explained by the fact that the testing conditions are already extended in PO2a leading to the major positive effect on the

[178] As there are no testing methods for brake emissions from lorries and buses and for tyre emissions from all vehicle categories developed so far, the environmental impact of those non-exhaust particles cannot be determined and subsequently assessed.

emission performance. The additional reduction of the NO_x limit from 150 mg/kWh to 100 mg/kWh in PO2b offers a low total emission reductions.[87]

On the other hand, additional reductions are expected for non-exhaust $PM_{2.5}$ emissions from cars/vans. PO2b includes more stringent limits for brake emissions which require improved brake pads and the installation of brake dust particle filter.

Figure 10 – NO_x reductions from light- and heavy-duty vehicles in PO2b compared to the baseline, Source: SIBYL/COPERT 2021



6.2.3 Social impacts

6.2.3.1 Monetised health and environmental benefits

Table 6 shows the monetised health and environmental benefits for PO2 compared to the baseline. The two different ambition levels for stricter emission limits, extended real-driving testing boundaries and durability requirements have high health and environmental benefits exceeding significantly the low benefit of PO1.

In PO2a, the reduction of NO_x emissions for cars/vans until 2050 is expected to result in health and environmental benefits of €32.7 billion, while the reduction for lorries/buses is expected to result in benefits of €88.8 billion. For cars/vans, PO2 is also expected to generate health and environmental benefits through a reduction in non-exhaust PM emissions through the inclusion of a new brake emission limit. For all vehicles, PO2 is additionally supposed to result in a reduction of N_2O and CH_4 emissions, of which health and environmental benefits are monetised as climate change cost[163,164].

While the health and environmental benefits related to NO_x, NMHC, N_2O, CH_4 and brake emissions are marginally higher in PO2b, there are no changes for exhaust PM and NH_3 as their emission limits remain the same in both sub-options.

Hence, the impact assessment shows that some of the concerns are justified, such as the marginal gains of PO2b with emission limits lower than 30 mg/km for NO_x and high ambitious real-world testing in all driving condition, resulting from high costs and marginal additional health and environmental benefits compared to PO2a.

Table 6 – Monetised health and environmental benefits for PO2 compared to the baseline, Source: SIBYL/COPERT 2021

	Monetised health and environmental benefits until 2050 (billion €)

	NO_x	$PM_{exhaust}$	$PM_{non-exhaust}$	NH_3	NMHC	N_2O+CH_4
PO2a – Medium Green Ambition						
Cars and vans	32.67	0.37	9.90	1.45	0.63	9.77
Lorries and buses	88.80	6.22	0.00	0.79	0.10	36.63
PO2b – High Green Ambition						
Cars and vans	33.24	0.44	14.85	1.46	0.70	14.46
Lorries and buses	89.32	6.29	0.00	0.80	0.11	37.49

6.2.3.2 Employment and skills

A low positive impact on employment at vehicle manufacturers is expected in PO2. Stricter emission limits in both stringency levels and comprehensive real-driving testing will require some additional workforces in the cars/vans as well as the lorries/buses segment due to the related R&D and manufacturing of new components in the vehicles' emission control systems.

In the targeted consultation, **automotive industry** expressed concerns that stringent emission limits and testing in all driving conditions may accelerate the shift to electric cars. While this possible shift has not been assessed quantitatively (as the model takes as a given the fleet of vehicles as projected in the high target level scenario of the impact assessment on CO_2 standards for cars and vans), no compelling reason was found to justify such an accelerated shift due to PO2.[174] The main driver to the electro-mobility transition is, and is expected to remain, climate policies. In fact, stricter emission limits and comprehensive real-driving testing are expected to result in small increase of regulatory costs. This increase does not amount to more than 2.1% of the current cars/vans prices in medium ambitious PO2a and 2.8% in the high ambitious PO2b (see Annex 4, Table 22).

In the targeted consultation, almost half of the component and equipment **suppliers** stressed that new emission limits will create new business opportunities and quality jobs, particularly in relation to technologies required in the emission control systems, engine optimisation and powertrain hybridisation components.[174]

Similarly, a low to moderate positive impact on skills at vehicle manufacturers and suppliers is expected in PO2 compared to the baseline. Stricter emission limits, new limits for brake emissions and extended coverage of pollutants and real-driving testing will require some re- and up-skilling of the workforce in the automotive supply chain of light- and heavy-duty vehicles to address the related R&D and manufacturing of new components in the vehicles' emission control systems. This is in line with the targeted consultation where a large share of industry, Member States and civil society stakeholders indicated that a higher-level education (38 out of 66) and new skills (47 out of 66) will be required for the majority of the personnel in the entire automotive supply chain to successfully apply the measures in PO2.[174] For type-approval authorities, no significant changes are expected in the required skills set. Stakeholders did not express different views on the cars/vans and lorries/buses segments.

The overall contribution of PO2 to the cumulative impact with CO_2 emission standards[32] on employment is not significant, since the sub-options are based in general on existing technologies not requiring a sector transformation. While the CO_2 emission standards for cars/vans are expected to result in the number of jobs increasing by 39 000 in 2030 and even by 588 000 in 2040, the low positive impact of PO2b could indicatively still lead to an additional increase of about 15 thousand jobs in 2030 in the cars/vans segment. On the other hand, PO2a is expected to have a no impact on employment (i.e. also no cumulative employment impact attributable to PO2a). See detailed analysis on the cumulative impacts on employment in Annex 4 chapter 1.5.3.

6.2.3.3 Consumer affordability

The total regulatory costs for industry introduced by PO2 are expected to be passed on to consumers, at least in the longer term. For PO2a and PO2b respectively, this leads in the most relevant segment for low-income consumers, i.e. small cars/vans, to 0.8-2.2% vehicle price increase for petrol vehicles and 2.1-2.8% for diesel vehicles (see Annex 4, Table 22). Impact on consumers' affordability will be low to moderate since diesel engine, where the additional measures are most expensive, is no longer technology of choice for this segment, especially in PO2a.

Private users are not considered as relevant for heavy-duty vehicles. The impact on SME users of heavy-duty vehicles are discussed in section 6.2.1.4.

While **automotive industry** has indicated that more stringent limits would lead to more costly vehicles and a slower fleet turn-over, the expected low impact on consumer affordability in PO2 is more in line with the views of the other stakeholder groups. In the targeted consultation, a **consumer organisation** stated that the previous Euro standards illustrate that an appropriate level of ambition can make vehicles significantly cleaner while not making them disproportionately more expensive.

Looking into the cumulative impact with the newly proposed CO_2 emission standards for cars/vans[32], PO2 is estimated to decrease the net saving in total cost of ownership (TCO) for combustion-engine cars/vans until 2035, but also after this date for zero-emission cars/vans through the proposed brake emission limits. For new cars and vans in 2030, the net TCO savings-first user of €600 achieved through the proposed CO_2 targets are expected to decrease by €114 per car and €258 per van in PO2a compared to €244 per car and €364 per van in PO2b. See detailed analysis on the cumulative impacts on consumers in Annex 4 section 1.5.2.

6.2.3.4 Consumer trust

PO2 with stricter emission limits and comprehensive real-driving testing conditions positively impact the consumer trust in automotive products as it ensures systematic clean vehicles performance.

Also the responses to the targeted consultation suggest that **stakeholders from all groups, except from vehicle manufacturers**,[179] believe that there is potential for a new Euro legislation to further improve consumer trust in emission performance of vehicles and automotive products.[180]

[179] Automotive industry, Member States and civil society

[180] CLOVE, 2022. Euro 7 Impact Assessment Study. ISBN 978-92-76-58693-7, chapter 5.1.4. Social impacts

6.3 PO3a: PO2a and Medium Digital Ambition

6.3.1 Economic impacts

6.3.1.1 Regulatory costs for automotive industry

The total regulatory costs for PO3a, adding medium digital ambition to PO2a by introducing Continuous Emission Monitoring (CEM) based on available sensor technology, are estimated in the range of PO2a.[181] The main reason for this is that the cost for available sensor technology is counterbalanced by higher costs savings due to simplified type-approval using CEM data. This finding should support the buy-in of industry stakeholders who raised concerns that the introduction of continuous emission monitoring in combination with stricter emission limits could be too burdensome for European car manufacturers. For cars/vans, total regulatory costs are estimated €304 per vehicle in PO3a.[182144] Similar to PO2a, these total regulatory cost estimate is below the total regulatory cost associated with introduction of Euro 6 for diesel cars/vans, but exceeds the costs associated with the introduction of Euro 6 for petrol cars/vans.[171] Although PO3a requires the installation of available sensors to allow for CEM, the respective increase in hardware, R&D and calibration costs (€21 per vehicle) is partly cancelled out by reduced costs during implementation phase and administrative costs (€14 per vehicle).

For lorries/buses, total regulatory costs are estimated at €2 681 per vehicle in PO3a. Thus, the increase in hardware, R&D and calibration costs linked to the introduction of CEM (€112 per vehicle) is partly offset by the increase in cost savings during implementation phase and administrative costs (€31 per vehicle). The total regulatory costs that came with the introduction of the Euro VI standards for lorries/buses are still found to be in a higher range (€3 717-€4 326 per vehicle).

In PO3, the administrative burden is further decreased as the new CEM requirements are expected to further simplify the reporting and other information provision obligations[146] for granting type-approval and verification procedures through reduced number of type-approvals. This leads to additional cost savings for all vehicle categories. In PO3a, administrative cost savings are estimated at €224 thousand per type-approval (€22 per vehicle) for diesel cars/vans and at €204 thousand per type approval for petrol cars/vans (€26 per vehicle).

For lorries/buses, the administrative cost savings in PO3a amount up to €66 thousand per diesel type-approval (€22 per vehicle) and €67 thousand per petrol type-approval (€47 per vehicle).

A detailed description of the total regulatory costs for automotive industry in PO3 compared to the baseline is available in Annex 4, section 1.3.1.3.

Table 7 presents the total regulatory costs in 5-year intervals over the period of implementation of medium ambition emission limits and introduction of available CEM in PO3, including tailpipe, evaporative and brake emissions. It shows that the largest

[181] PO3b on PO2a and High Digital Ambition has been discarded at an early stage (see 5.3).
[182] For cars/vans, this cost per vehicle corresponds to €287 per ICE vehicle for costs linked to requirements for tailpipe and evaporative emissions and €17 per vehicle for all powertrains linked to requirements for brake emissions.

share of the costs occur in the first ten years after 2025. After that, the costs will decrease with a **small share of the costs remaining after 2035**, mainly resulting from **brake emissions requirements for all cars and vans, including zero-emission vehicles**, and **combustion-engine lorries/buses.** They will also be due to the need to continue market surveillance and in-service conformity checks throughout the lifetime to vehicles (i.e. at least for another 10-15 years after the first registration).

Table 7 – Expected distribution of total regulatory costs in PO3a compared to the baseline, in billion € and 2025 NPV

	2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	Total
Cars and vans	8.91	15.05	4.23	1.03	0.86	0.72	30.80
Lorries and buses	6.11	6.01	2.18	1.33	0.74	0.56	16.94

Taking into account the market share of car/van manufacturers in the EU[149], over the 25-year period the two largest manufacturing groups, would have to invest between €5.1 and €5.7 billion each in PO3a for the whole period 2025 to 2050. For all other car/van manufacturers, PO3a would only require a total investment between €0.6 and €2.8 billion depending on the size for the whole period. This a small additional amount to the €59 billion each car manufacturer is expected to invest for the shift to automation, connectivity and electrification. [151]

The total regulatory costs for the industry divided by 12 main manufacturers of lorries/buses translate to investment of €1.4 billion per lorries/bus manufacturer for PO3a.

Especially **automotive industry** has raised concerns regarding too high cumulative impacts in view of the CO_2 investments. With the end-date of combustion-engine cars/vans by 2035, the cumulative annual investment of PO3a and proposed CO_2 emission standards[32] over 2021-2040 amounts to €20.2 billion, out of which €19 billion is due to the proposed CO_2 target and €1.2 billion due to PO3a (see Annex 4, Table 33). The investment attributable to PO3a is considered with 7% increase in annual investments not too high. See detailed analysis on the cumulative impacts on industry in Annex 4 section 1.5.4.

Table 5 (II.C) in Annex 3 presents an overview of these regulatory costs for manufacturers split up in one-off and recurrent costs linked to the different policy measures, including simplification measures, medium ambition emission limits, real driving testing boundaries and durability and medium ambition continuous emission monitoring.

6.3.1.2 Competitiveness

Since the medium ambition stricter emission limits and real driving testing boundaries of PO2a are also part of PO3a, the arguments relevant for PO2 are also applicable for both vehicle segments in this policy option. While the majority of component **suppliers** participating in the targeted consultation indicated that continuous emission monitoring in combination with stricter emission limits would positively affect the competitive position of the EU automotive industry, **vehicle manufacturers** consider it too burdensome.

Next to a medium green ambition, PO3a also introduced a medium digital ambition by introducing requirements regarding continuous emission monitoring systems. PO3a is expected to have a moderate positive effect on competitiveness in terms of innovation and access to international markets. Continuous emission monitoring systems are relevant in several third markets for which cleaner ICE vehicles are still needed in view of an expected higher age of the vehicle fleet than the up to 19 years in the EU cars/vans fleet and up to 21 years in the EU lorries/buses fleet[183].

The introduction of CEM with modern IT functionalities in PO3a is considered as an element of digital **innovation** in the automotive sector. In addition, the development of sensors and digital communication systems creates opportunities, some of them beyond the automotive supply-chain i.a. in cybersecurity area[184]. European suppliers of communication systems are expected to develop secure protocols for the transmission of information and other IT solution to protect the emission control systems from tampering under PO3 and to facilitate the secure transmission of data. Further synergies with the access to data regulations are also expected, ensuring adequate protection of personal data which are not needed for checking compliance of a vehicle type. It is also worthwhile mentioning that the introduction of CEM is expected to be of high interest for periodic technical inspections and roadside checks of vehicles.

Similar developments in other key markets in the field of continuous emission monitoring (US with REAL initiative, China with remote on-board diagnostics for heavy-duty vehicles) demonstrate that PO3a could further close the gap between the EU and other countries emission standards.

Lastly, PO3a will also facilitate the implementation of geo-fencing. As a consequence, new business models using the information collected can be developed to support the concept of Smart Cities[185] and to offer new solutions regarding the improvement of air quality.

Despite the regulatory costs for industry and cumulative investments with CO_2 emission standards (see 6.3.1.1), stimulating digital, green and electric innovation would allow the EU automotive sector to maintain access to international markets which would improve its competitive position over the baseline. Since cost for available sensor technology, as assumed in PO3a, is counterbalanced by costs savings due to simplified type-approval (see 6.3.1.1), the investment for PO3a is not higher than for PO2a and not considered too burdensome for vehicle manufacturers.

6.3.1.3 Single market

PO3 would significantly improve and simplify compliance of motor vehicles with emission rules and therefore improve the trust on the automotive sector. The possibility to introduce geo-fencing possibilities could allow a wider range of powertrains in zero-emission zones (i.e. zero-emission enabled PHEVs). That way, PO3a could counter the national measures (e.g. zero-emissions zones or phasing-out combustion engines, see section 2.3) and preserve the single market.

[183] ACEA, 2021. Average age of the EU vehicle fleet, by country.
[184] UC Riverside, 2020. How to create a paradigm shift in vehicle emission regulation
[185] European Commission, 2022. Smart cities

6.3.1.4 SMEs

The CEM requirements could be more difficult and costly to implement for the 35 SME cars/vans manufacturers[186] (see 6.1.1.4). Considering that those SMEs use engines equipped with on-board fuel consumption meters (OBFCM)[137] from larger manufacturers, the implementation of available sensor technologies based on the OBFCM communication platform is not expected to be a challenge.

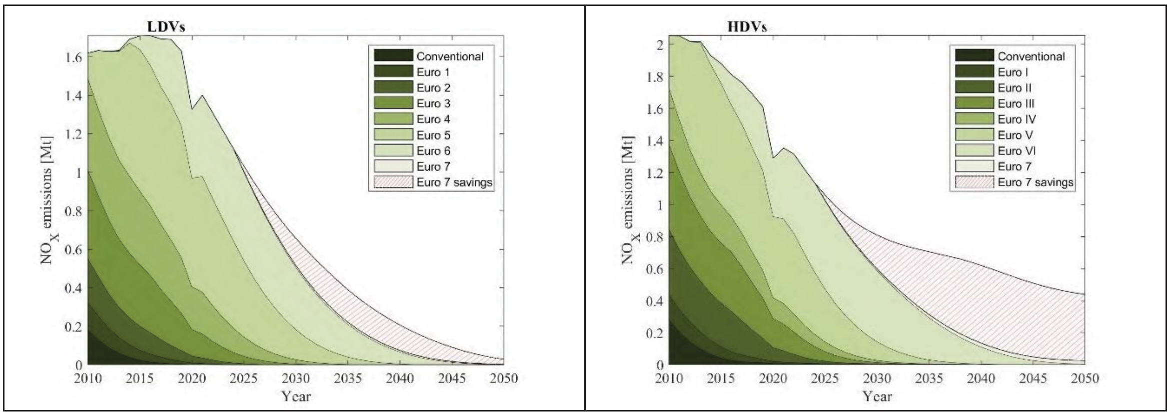
As the total regulatory costs related to PO3 are expected to be passed on to SME users, they are mostly concerned about the affordability of vehicles. Similar to PO2a, the total regulatory costs in PO3a amount up to 2.2% for small cars/vans and up to 3.2% for small lorries of the vehicle price (see Annex 4, Table 25). Hence, the introduction of CEM is expected to have medium negative impact on the affordability for SME users.

6.3.2 Environmental impacts

As illustrated for key pollutant NO_x in Figure 11 and all pollutants in Annex 4, Table 14, the emission reductions that can be expected in PO3a compared to the baseline are significant, in particular for lorries/buses. Also for cars/vans, very low NO_x emission levels are reached in 2040, compared to 2050 in the baseline (see 6.2.2).

Through the introduction of continuous emission monitoring for NO_x and NH_3 emissions, some additional emission reductions are expected compared to the introduction of strict emission limits only (PO2a). This is due to improved compliance with emission limits and improved protection against tampering with the emission control systems.

Figure 11 – NO_x reductions from light- and heavy-duty vehicles in PO3a compared to the baseline, Source: SIBYL/COPERT 2021



6.3.3 Social impacts

6.3.3.1 Monetised health and environmental benefits

Table 8 shows the monetised health and environmental benefits for PO3a compared to the baseline. New CEM requirements in a Medium Digital Ambition, in addition to the

[186] No SMEs were identified in the lorries/bus segment.

medium ambition stricter emission limits and extended real-driving testing boundaries in PO2a, are expected to result in additional benefits for nearly all pollutants.

In PO3a, some additional health and environmental benefits could be realised through the monitoring of NO_x and NH_3 over the vehicle lifetime (see Annex 6, Table 55). The reduction of NO_x emissions for cars/vans until 2050 is expected to result in a health and environmental benefit of €33.5 billion, while for lorries/buses it is expected to result in a benefit of €89.6 billion. Also the emission reductions for NH_3 in PO3 result in additional health and environmental benefits beyond PO2, more so for lorries/buses than for cars/vans. These benefits are expected to amount up to €1.5 billion for cars/vans (€60-€50 million more than in PO2a and PO2b) and up to €0.9 billion for lorries/buses.

Table 8 – Monetised health and environmental benefits for PO3a compared to the baseline, Source: SIBYL/COPERT 2021

	Monetised health and environmental benefits until 2050 (billion €)					
	NO_x	$PM_{exhaust}$	$PM_{non-exhaust}$	NH_3	NMHC	N_2O+CH_4
Cars and vans	33.45	0.37	9.90	1.51	0.67	9.77
Lorries and buses	89.63	6.22	0.00	0.91	0.10	36.63

6.3.3.2 Employment and skills

In PO3, a low positive impact is expected on employment by vehicle manufacturers. The introduction of CEM in addition to stricter emission limits, will require some additional workforce for the manufacturing and R&D for new components in the vehicles' emission control systems and new specialised IT jobs on data communication. The CEM functionality could simplify and modernise the existing on-board diagnostics.

PO3 is expected to result in a direct positive impact on employment, exceeding the impacts of PO2a, in the supply segment of the industry. CEM would require the most intensive R&D and innovation activity among all options to develop and implement the necessary technologies (e.g. on-board sensors and intelligent vehicle communication protocols). This would apply for cars/vans as well as lorries/buses, since sensors are designed for application in all vehicles, light and heavy-duty ones. In addition, almost half of the suppliers stressed in the targeted consultation that the requirements in PO3 could create new business opportunities and quality jobs in the field of sensor technology.

A large share of **industry, Member States and civil society stakeholders** indicated that a higher-level education and new skills will be required for the majority of the personnel in the entire automotive supply chain to successfully apply the measures in PO3a. Compared to the baseline and the previous policy options, a significant up- and re-skilling of the workforce in the automotive supply chain is expected due to the introduction of CEM.

While the **automotive industry** is already expanding relevant expertise by investing in module integration, software development and semiconductor design[187], CEM is

[187] Roland Berger, 2020. The car will become a computer on wheels

expected to further encourage demand for connected vehicles with advanced electronic information and communication. Therefore, the industry will need re- and up-skilling in order to bridge the existing knowledge gap between the automotive and ICT sector and contribute to the digital transformation. This will be a key enabler for reaching the Green Deal objectives.

Some re- and up-skilling regarding sensor operation and verification may be required for type-approval authorities. In PO3, in-service conformity and market surveillance are expected to be mostly dependent on the verification of on-board monitored emissions of the vehicle model family.

The contribution of PO3a to the cumulative impact with CO_2 emission standards[32] on employment is expected to be low, since it is based on existing technologies not requiring a sector transformation. While the CO_2 emission standards for cars/vans are expected to result in the number of jobs increasing by 39 000 in 2030 and even by 588 000 in 2040, the low positive impact of PO3a could indicatively lead to an additional increase of about 9 thousand jobs in 2030 in the cars/vans segment. See detailed analysis on the cumulative impacts on employment in Annex 4 section 1.5.3.

6.3.3.3 Consumer affordability

The total regulatory costs for industry introduced by PO3 are expected to be passed on to the consumers, at least in the longer term. This is especially important for the segment of small cars/vans which is the most relevant for low-income consumers. For small petrol vehicles, PO3a is expected to lead to vehicle price increases up to 0.8% (see Annex 4, Table 25). The impact on consumer affordability will be low since small diesel vehicles, with an estimated price increase of 2.2%, are no longer the technology of choice for the small vehicle segment. This conclusion is in line with the view from a **consumer organisation** which stated that an appropriate level of ambition can make vehicles significantly cleaner while not making them disproportionately more expensive.

Private users are not considered relevant for heavy-duty vehicles. The impact on SME users of heavy-duty vehicles are discussed in section 6.3.1.4.

Looking into the cumulative impact with the newly proposed CO_2 emission standards for cars/vans[32], PO3 is estimated to decrease the net savings in total cost of ownership (TCO)-first user from €600 per vehicle by €112 for cars and by €255 for vans in 2030. See detailed analysis on the cumulative impacts on consumers in Annex 4 section 1.5.2.

6.3.3.4 Consumer trust

Through continuous emission monitoring, more information regarding the emission performance of vehicles could be made available to consumers. The digital solutions offered in this policy option could positively affect the consumers' perception of the emission standards and subsequently improve consumer trust in good environmental performance of vehicles. Continuous emission monitoring is expected to help detecting non-compliance and malfunction at an early stage which should lead to vehicles emitting less pollutants over their lifetime. Consumers and the general public get higher assurance that their vehicles continues to be clean during its use. Hence, it is expected that PO3 has an additional positive impact on consumer trust compared to PO2a.

7 HOW DO THE OPTIONS COMPARE?

The options are compared against the following criteria:

- Effectiveness: the extent to which the different options would achieve the specific objectives;
- Efficiency: the extent to which the benefits can be achieved for a given level of resource/at least cost;
- Coherence of each option with other EU rules tackling air pollutants in the road transport sector;
- Proportionality: overall assessment of the effectiveness, efficiency and coherence of each of the options.

Table 9 and Table 10 summarise the assessment of each option against those criteria, differentiated between light- and heavy-duty vehicles and following the impacts assessed in chapter 6. Given that there is no weighing of the impacts, major impacts and the other impacts which have less impact on stakeholders are distinguished.

Table 9 – Comparison of the policy options for light-duty vehicles in terms of effectiveness, efficiency and coherence[1]

Policy option	1 – Low Green Ambition	2a – Medium Green Ambition	2b – High Green Ambition	3a – 2a and Medium Digital Ambition
Effectiveness				
Reduce complexity of the current Euro emission standards	++	++	++	+++
Provide up-to-date limits for all relevant air pollutants	**0**	++	+++	++
Improve control of real-world emissions	+	++	++	+++
Efficiency				
A. Major impacts on industry				
Regulatory costs: Equipment costs	-	--	---	--
Regulatory costs savings: Testing, witnessing, type-approval and administrative costs savings	++	++	++	+++
Competitiveness: Access to international key markets	**0**	+	+	++
Competitiveness: Innovation	**0**	**0**	+	++
B. Other impacts on industry				
Free movement within the single market	**0**	**0**	+	+
Affordability for SME users	**0**	-	--	-
C. Major impacts on citizens				
Health and environmental benefits	+	++	+++	++
Consumer affordability	**0**	-	--	-
D. Other impacts on citizens				
Consumer trust	+	++	++	+++
Employment and skills	**0**	**0**	+	+
Quantitative efficiency				
Net benefits	**0**	+	--	+
Coherence				
European Green Deal: Green and digital transformation	**0**	++	+++	+++
Ambient Air Quality/ National Emission reduction Commitments Directives	**0**	+	++	+
CO_2 emission standards	**0**	+	++	+
Roadworthiness	+	+	+	+++

[1] --- high negative, -- moderate negative, - low negative, 0 neutral, + low positive, ++ moderate positive, +++ high positive

Table 10 – Comparison of the policy options for heavy-duty vehicles in terms of effectiveness, efficiency and coherence[1]

Policy option	1 – Low Green Ambition	2a – Medium Green Ambition	2b – High Green Ambition	3a – 2a and Digital Ambition
Effectiveness				
Reduce complexity of the current Euro emission standards	++	++	++	+++
Provide up-to-date limits for all relevant air pollutants	**0**	++	+++	++
Improve control of real-world emissions	+	++	++	+++
Efficiency				
A. Major impacts on industry				
Regulatory costs: Equipment costs	**0**	-	--	-
Regulatory costs savings: Testing, witnessing, type-approval and administrative costs savings	+	+	+	++
Competitiveness: Access to international key markets	**0**	+	+	++
Competitiveness: Innovation	**0**	**0**	+	++
B. Other impacts on industry				
Free movement within the single market	**0**	**0**	+	+
Affordability for SME users	**0**	-	--	-
C. Major impacts on citizens				
Health and environmental benefits	+	+++	+++	+++
Consumer affordability	Private users not relevant for heavy-duty vehicles			
D. Other impacts on citizens				
Consumer trust	+	++	++	+++
Employment and skills	**0**	**0**	+	+
Quantitative efficiency				
Net benefits	**0**	+++	++	+++
Coherence				
European Green Deal: Green and digital transformation	**0**	++	++	+++
Ambient Air Quality/ National Emission reduction Commitments Directives	**0**	++	+++	++
CO_2 emission standards	**0**	++	+++	++
Roadworthiness Directives	+	+	+	+++

[1] --- high negative, -- moderate negative, - low negative, 0 neutral, + low positive, ++ moderate positive, +++ high positive.

7.1 Effectiveness

The policy options address to different degrees the specific objectives of the initiative, without going beyond what is necessary.

Concerning the specific objective to **reduce complexity of the current Euro emission standards**, it is effective that the proposed Euro 7 regulation combines Euro 6 emission standards for cars/vans and Euro VI emission standards for lorries/buses in one single regulation, with simplification measures such as references to relevant UNECE regulations regarding testing procedures, fuel- and technology-neutral limits and the use of a single date of Euro 7 introduction per vehicle segment applied for all cars/vans and lorries/buses respectively in all policy options. For cars/vans as well as lorries/buses, PO3a seems to be most suitable to reduce complexity, as continuous emission monitoring equipment is expected to simplify the reporting and other information provision obligations for granting of type-approval and ease the verification testing procedures.

Due to the strictest update of existing emission limits and setting of new ones, PO2b is considered for cars/vans as well as lorries/buses as most effective regarding the specific objective to **provide up-to-date limits for all relevant air pollutants.** PO1 is considered to be not more effective than the baseline as the update of obsolete limits is too limited. PO2a and PO3a are slightly less ambitious than PO2b, but go significantly beyond PO1 for all vehicles.

Regarding the specific objective to **improve control of real-world emissions**, the effect of PO1 is rather limited as the RDE testing conditions are only slightly and the durability requirements are not expanded compared to Euro 6/VI. PO2a/PO2b go further by extending the durability to the average/full lifetime of the vehicle and covering medium/high ambitious real-driving testing conditions. However, the additional use of continuous emission monitoring through on-board sensors, in addition to PO2a, leads to the highest effectiveness in PO3a for cars/vans as well as lorries/buses.

7.2 Efficiency

Major impacts on industry

Regulatory costs (covering substantive compliance costs due to equipment costs for emission control technologies and the related R&D and calibration costs including facilities and tooling costs) are assessed to be highest for PO2b, in the order of €67 billion between 2025 and 2050 for light-duty vehicles and €26 billion for heavy-duty vehicles, due to the use of more advanced equipment for emission control (brake filters for cars/vans segment instead of brake pads used in PO2a and PO3a, and advanced tailpipe emission control technology for both vehicle segments). PO1 is the least costly as only limited emission control technologies are introduced for light-duty vehicles and none for heavy-duty vehicles.

In terms of **regulatory costs savings** (covering substantive compliance costs savings during testing, witnessing of tests by type-approval authorities and type-approval fees as well as administrative costs savings for reporting and other information obligation as part of the type-approval procedures), the assessment indicates for all policy options a reduction compared to baseline in the order of €3.5 to €4.7 billion until 2050 for light-duty vehicles and €0.4 to €0.6 billion for heavy-duty vehicles. This difference is due to the limited number of heavy-duty vehicles sold each year. PO3a shows for all vehicles higher reductions than the other options, as continuous emission monitoring equipment is expected to facilitate the type-approval and testing procedures.

Especially automotive industry has raised concerns regarding too high **cumulative investments with CO_2 emission standards**. With the end-date of combustion-engine cars/vans by 2035, the cumulative annual investment of PO2a/PO2b/PO3a and CO_2 emission standards[32] over 2021-2040 for the whole automotive industry amounts to €20.2/€21.4/€20.2 billion, out of which €19 billion is due to the proposed CO_2 target and €1.2/€2.4/€1.2 billion[188] due to PO2a/PO2b/PO3a. The investment attributable to PO2a and PO3a are considered not too high, while the investment attributable to PO2b is considered with 13% high.

Despite the regulatory costs for industry and cumulative investments with CO_2 emission standards, PO2 and PO3 are expected to have some positive effect on **competitiveness**. PO3a shows for cars/vans as well as lorries/buses the highest positive impacts in terms of **access to international key markets** and **innovation**. This is due to new market opportunities stemming from the use of available sensors. The use of best available emission control technologies and sensors in PO3a supports access to international key markets, in particular United States and China. Stimulating twin innovation in zero-emission technologies by proposed CO_2 emission standards and in low emission technology by proposed Euro 7 pollutant standards, the competitive position of the EU automotive sector can be improved over the baseline.

Other impacts on industry

PO3a and PO2b are considered to have some positive impact on the **single market** for both vehicle segments. Introduction of the best available emission control technologies and continuous emission monitoring on EU level could prevent Member States from taking unilateral decisions to address excessive emissions from road transport. PO3a offers additionally the possibility of geo-fencing to support Member States and cities in their journey towards improving air quality in densely populated areas. This technology could make it possible to allow a wider range of powertrains in zero-emission zones (i.e. zero-emission enabled PHEVs).

As far as SMEs are concerned, no significant impacts are expected, except of **affordability for SME users** (e.g. transport or logistics services, vehicle rental or leasing companies, companies using vehicles). Vehicle prices are expected to increase due to additional costs for emission control systems. This effect is expected to be the most pronounced in the smaller vehicle segments with lower average prices. For small cars/vans, a low negative impact on the affordability for SME users is supposed in PO2a and PO3a where total regulatory costs could reach about 2% of the vehicle price. A medium negative impact is assumed in PO2b where the total regulatory costs could reach about 3% of the vehicle price. For small lorries, also a low negative impact is expected in PO2a and PO3a, whereas a medium negative impact is supposed in PO2b.

[188] While in the CO_2 impact assessment the investments are assessed over the period 2021-2040, Euro 7 investments only start in 2025 after its application. Nevertheless, the annual average of Euro 7 is still calculated over the period 2021-2040 to provide comparable numbers with the investments in the CO_2 impact assessment. (For more information see Annex 4: chapter 1.5.4. Cumulative impacts on industry)

Major impacts on citizens

PO2a, PO2b and PO3a offer substantial **health and environmental benefits** due to reduced emissions of harmful air pollutants (see Table 11 and Table 12). The main benefits for citizens are substantial health benefits, expected to result in a reduction of medical treatment costs, production losses due to illnesses and even deaths. Since the emission savings also reflect reduced damage costs on crop and biodiversity losses and material and building damage, i.e. environmental benefits, no policy option is expected to do significant harm to the environmental Sustainable Development Goals. **The main driver of the high positive impacts is the reduction of NO_x and $PM_{2.5}$ emissions, while the reduction potential for heavy-duty vehicles is in kilotons twice as high as for light-duty vehicles.**

Table 11 – Assessment of the environmental impacts of policy options compared to the baseline: reduction of emissions of air pollutants in 2035 for cars/vans, Data source: SIBYL/COPERT 2021

Pollutant	Latest available emissions	Baseline	1 – Low Green Ambition	2a – Medium Green Ambition	2b – High Green Ambition	3a – 2a and Medium Digital Ambition
	2018 in kt	2035 in kt, % compared to baseline				
NO_X	1 689.67	389.40	285.30 (-27%)	224.40 (-42%)	221.80 (-43%)	220.80 (-43%)
$PM_{2,5,\ brake\ emissions}$	14.90	16.04	16.04 (-0%)	11.82 (-26%)	9.71 (-40%)	11.82 (-26%)
$PM_{2,5,exhaust}$	43.85	1.50	1.31 (-13%)	1.28 (-15%)	1.25 (-16%)	1.28 (-15%)
PN_{10} [in #]	$6.55x10^{25}$	$1.92x10^{24}$	$1.63x10^{24}$ (-15%)	$1.06x10^{24}$ (-45%)	$1.05x10^{24}$ (-45%)	$1.06x10^{24}$ (-45%)
CO	2 796.13	584.50	550.50 (-6%)	414.90 (-29%)	405.10 (-31%)	414.90 (-29%)
THC	412.22	146.10	145.50 (-0%)	113.20 (-23%)	110.50 (-24%)	111.50 (-24%)
NMHC	369.70	119.20	119.00 (-0%)	93.80 (-21%)	91.10 (-24%)	92.11 (-23%)
NH_3	38.41	23.85	18.73 (-21%)	16.15 (-32%)	16.14 (-32%)	15.90 (-33%)
CH_4	42.52	26.85	26.52 (-1%)	19.42 (-28%)	19.38 (-28%)	19.42 (-28%)
N_2O	16.34	41.26	40.69 (-1%)	28.91 (-30%)	23.81 (-42%)	28.91 (-30%)

Table 12 – Assessment of the environmental impacts of policy options compared to the baseline: reduction of emissions of air pollutants in 2035 for lorries/buses, Data source: SIBYL/COPERT 2021

Pollutant	Latest available emissions	Baseline	1 – Low Green Ambition	2a – Medium Green Ambition	2b – High Green Ambition	3a – 2a and Medium Digital Ambition
	2018 in kt	2035 in kt, % compared to baseline				
NO_X	1 689.73	705.40	605.60 (-14%)	316.10 (-55%)	314.00 (-55%)	312.60 (-56%)
$PM_{2,5}$, brake emissions	-	-	-	-	-	-
$PM_{2,5}$, exhaust	23.45	8.81	8.81 (-0%)	5.37 (-39%)	5.35 (-39%)	5.37 (-39%)
PN_{10} [#]	3.70×10^{25}	7.49×10^{23}	7.49×10^{23} (-0%)	4.06×10^{23} (-46%)	4.05×10^{23} (-46%)	4.06×10^{23} (-46%)
CO	412.92	111.50	111.50 (-0%)	97.90 (-12%)	89.08 (-20%)	97.93 (-12%)
THC	43.38	26.55	26.55 (-0%)	23.06 (-13%)	22.84 (-14%)	23.06 (-13%)
NMHC	36.71	16.66	16.66 (-0%)	12.95 (-22%)	12.77 (-23%)	12.95 (-22%)
NH_3	6.46	9.64	9.64 (-0%)	6.45 (-33%)	6.43 (-33%)	6.00 (-38%)
CH_4	6.67	9.89	9.89 (-0%)	10.10 (+2.1%)	10.07 (+1.8%)	10.10 (+2.1%)
N_2O	57.13	97.80	97.80 (-0%)	58.30 (-40%)	58.10 (-41%)	58.30 (-40%)

The impact of the new requirements on **consumer affordability** in the cars/vans segment would be limited[189]. The total regulatory costs compared to baseline are expected to be passed on to consumers, while the impact of the affordability for lorries/buses is explained under the impacts to the industry and SMEs. This leads in PO2 and PO3 in the segment of small petrol cars/vans, which is the most relevant for low-income consumers, to a 0.8-2.2% increase in petrol vehicle prices. While the highest price increase of 2.8% for diesel vehicles in PO2b is above the price increase in the previous Euro standard, the impact on consumers' affordability will be limited considering that this is no longer the technology of choice for this segment. The impact on the affordability of the second-hand consumers is expected to be even less. This conclusion is in line with the view from a **consumer organisation** which stated that an appropriate level of ambition can make vehicles significantly cleaner while not making them disproportionately more expensive.

When looking into the **cumulative consumer affordability with the proposed CO_2 emission standards for cars/vans**, the concept of total cost of ownership (TCO)-first user has to be used. Since fuel and electricity savings from the use of zero-emission vehicles are significant for consumers, the CO_2 emission standards decrease the total cost of ownership (TCO) of such vehicles. The 1.7-2.3% increase in diesel vehicle prices in PO2a, PO2b and PO3a leads for the consumer to a decrease of the TCO savings in 2030 from €600 per car/van when only the effect of a 100% CO_2 target in 2035 is taken into

[189] Private users/consumers are considered not relevant in the lorries/buses segment. The affordability for SME users of this vehicle segment are discussed above under "other impacts on industry".

account to €486, €356 and €488 per car/van when additionally the effect of PO2a, PO2b and PO3a are taken into account.

Other impacts on citizens

All policy options are expected to have positive impacts on **consumer trust**, as they improve vehicles' environmental impact. The impact is expected to be most extensive for all vehicles in PO3a which enables sharing more and reliable information on emission performance of vehicles to consumers through continuous emission monitoring.

The introduction of stricter emission limits and continuous emission monitoring (PO2b, PO3a) is expected to have for cars/vans as well as lorries/buses a low positive impact on **employment and re- and up-skilling of workforces.**

Since the policy options are based in general on existing technologies not requiring a sector transformation, the contribution to the **cumulative impact on employment with the CO_2 emission standards** is not significant. While the CO_2 emission standards for cars/vans are expected to result in the number of jobs increasing by 39 000 in 2030 and even by 588 000 in 2040, the low positive impact of PO2b and PO3a could indicatively still lead to an additional increase of about 15 thousand and 9 thousand jobs in 2030 in the cars/vans segment. About half of the **vehicle manufacturers** also claimed that employment in businesses focused on traditional combustion-engines would be negatively affected. This employment effect due to the shift to electric vehicles has been taken into account in these cumulative impacts.

Quantitative efficiency

In order to assess the quantitative efficiency of policy options, total regulatory costs are compared to the monetised health and environmental benefits of a reduction of air pollution (as **net benefits i.e. the difference between the present value of the benefits and costs**)[190]. The baseline against which the policy options are assessed until 2050 considers that fleet renewal would lead to a higher share of Euro 6/VI vehicles in the vehicles mix, an end-date of combustion-engine cars/vans in 2035 and a decrease of combustion-engine lorries/buses in line with the projected HDV fleets (see 5.1).

The main benefits of the policy options are substantial health and also environmental benefits for citizens due to reduced emissions of harmful air pollutants from cars/vans as well as from lorries/buses. This health and environmental benefit can be monetised using the concept of external costs developed for the Commission's Handbook on the external costs of transport. It reflects the damage costs by air pollution to health and environment, in particular medical treatment costs, production losses due to illnesses and even deaths.

[190] For methodological reasons and for clarity purposes, the focus of the efficiency assessment is on net benefits which are an indicator of the attractiveness of an option in absolute terms (thus the larger the difference between benefits and costs, the better) and do not bias the results for low-cost options, compared to the benefit-cost ratio (BCR). The BCR gets disproportionally high when costs are low which gives an unjustified advantage to low-cost options (i.e. PO1) and has the potential to mislead policy makers. Moreover, the BCR is independent form the scale of options considered, which contradicts the necessity to consider in absolute terms the regulatory costs and environmental and health benefits of reducing air pollutants. The BCR is therefore disregarded to choose one option and is included in Tables 27, 29, 59 and 60 of the Annexes 4 and 8 for completeness purposes only.

In addition, the benefits reflect impact on the environment by air pollutants such as crop and biodiversity losses as well as material and building damage.

The total regulatory costs in the cars/vans as well as in the lorries/buses segment consist of 1) equipment costs for emission control technologies and the related R&D and calibration costs including facilities and tooling costs, 2) costs during implementation phase for testing, witnessing of tests by type-approval authorities and type-approval fees and 3) administrative costs (reporting and other information obligations as part of the type-approval procedures). In all policy options the increase in total regulatory costs is due to 1) equipment costs, reduced by 2) cost savings during the implementation phase and 3) administrative costs savings both due to simplification measures (see Annex 4, Table 15, 18, 19 and 23). Regulatory cost from 1) is considered as cost; and regulatory costs savings from 2) and 3) are considered as benefit in the efficiency assessment.

As shown in Table 13, the benefits outweigh the costs in the policy options, except in PO2b for cars/vans in which the benefits equal the costs. For the other policy options, positive results are also expected when considering the medium to high level of confidence of the benefits and cost estimations (see details on uncertainty of the cost-benefit analysis in Annex 4, section 1.3.2.1).

For cars/vans, PO2a and PO3a are estimated to lead to sufficient net benefits among the analysed options with an average of about €25 billion and a range from €22-€28 billion. However, for PO2b, based on more advanced emission control technologies such as brake filters instead of brake pads leading to higher costs, the low net benefits are with the range of €0.87-€1.81 billion considered not sufficient.

For lorries/buses, PO2a and PO3a offer very high net benefits with an average of about €117 billion and a range from €99-€134 billion, while PO2b shows lower relative benefits. **The difference in net benefits compared to cars/vans can be explained by the higher emission reduction potential for HDV.**

For all vehicles, PO1 offers only low net benefits, compared to other options. Although PO1 is estimated to lead to significantly lower regulatory costs due to minimal change to the emission limits and testing requirements and cost savings by simplification measures, the health and environmental benefits in terms of emission reductions are however lower than for all other policy options.

To further analyse PO2a and PO3a having about the same average net benefit as well as different net benefits in the cars/vans and lorries/buses segment, qualitative elements of the effectiveness, efficiency and coherence analysis will be taken into account in the proportionality analysis (see 7.4).

Table 13 – Assessment of quantitative efficiency of policy options for light- and heavy-duty vehicles compared to baseline*, 2025-2050, Introduction of Euro 7 in 2025, Data source: SIBYL/COPERT 2021

Policy option	1 – Low Green Ambition	2a – Medium Green Ambition	2b – High Green Ambition	3a – 2a and Medium Digital Ambition
Cars and vans				
Health and environmental benefits, 2025 NPV in billion €	22.37±3.29	54.82±8.22	65.18±9.77	55.75±8.35
Regulatory costs savings, 2025 NPV in billion €	3.50±0.35	3.45±0.35	3.45±0.35	4.67±0.47
Regulatory costs, 2025 NPV in billion €	8.54±1.41	33.73±5.52	67.30±10.58	35.48±5.71
Net benefits, 2025 NPV in billion €	**17.33±2.23**	**24.55±3.05**	**1.34±0.47**	**24.94±3.11**
Lorries and buses				
Health and environmental benefits, 2025 NPV in billion €	21.14±3.17	132.54±19.88	134.01±20.10	133.58±20.02
Regulatory costs savings, 2025 NPV in billion €	0.38±0.04	0.38±0.04	0.38±0.04	0.58±0.06
Regulatory costs, 2025 NPV in billion €	0.65±0.13	16.82±2.92	26.03±4.30	17.53±3.05
Net benefits, 2025 NPV in billion €	**20.86±3.08**	**116.10±17.00**	**108.36±15.84**	**116.64±17.03**

** The baseline considers an end-date of combustion-engine cars/vans in 2035, see section 5.1.*

Alternative set of assumptions on emission limits and durability

In the stakeholder consultations, automotive industry and civil society representatives raised concerns, often having diverging opinions, regarding the level of emission limits, length of durability requirements and the technological potential for reducing emissions over the lifetime of the vehicles. In addition to the different emission limits and durability assumed in the examined policy options an alternative set of assumptions was assessed to address remaining uncertainty around the medium green ambition on emission limits and durability in PO2a. It allows in particular to test the sensitivity of the environmental gains to the choice of the emissions limits, and the respective costs and benefits of increasing the durability of the measures.

The assessment has been carried out, based on two scenarios for each type of vehicle: one scenario assumes slightly higher (i.e. less ambitious) emission limits when compared to the medium ambition emission limits in PO2a (see Table 56 in Annex 8). Another scenario assumes increased durability by extending the durability from the average to the full lifetime of light- and heavy-duty vehicles. The alternative assumption on emission limits leads to lower emission savings when compared with PO2a, but it still results in the same regulatory costs (see Table 59 in Annex 8). The alternative assumption on durability results in slightly higher health and environmental benefits, while also increasing hardware costs lead to slightly higher regulatory costs (see Table 60 in Annex 8). In conclusion, the net benefits of the alternative set of assumptions are, in case of durability requirements, the same or, in case of emission limits, just slightly worse than PO2a, while remaining overall largely positive. **This conclusion is valid for light- and heavy-duty vehicles.**

Since the emission limits and durability assumptions are the same in PO2a and PO3a, for light-and heavy-duty vehicles, the conclusions drawn are also valid for PO3a.

7.3 Coherence

As aimed high in the **European Green Deal**, all sectors should undergo a **green and digital transformation**, including the road transport, to reach zero-pollution ambition for a toxic-free environment.

Transport should become drastically less polluting, especially in cities and Euro 7 is considered as a vital part of the transition towards zero-emission vehicles on EU roads. PO2b is considered for light-duty vehicles most effective towards zero-emission cars/vans on EU road due to the use of best available emission control technology, closely followed by PO3a using existing emission control and sensor technology. For heavy-duty vehicles, PO3a is considered most effective towards zero-emission lorries/buses on EU road. This difference between the vehicle segments is due to the fact that effective brake filters that have a high benefit can be considered in PO2b for the moment only for cars/vans (no brake emission data available for HDV). This may change in the future, once the brake filters are a more mature technology, and they may also be applied for heavy-duty applications. Moreover, NO_x emissions are already at such a very low average emission level in PO2a that further amelioration due to stricter emission levels or continuous emission monitoring have also a very low effect on emissions. Synergies should be looked for between the twin green and digital transformation, as encouraged by the European Green Deal and the New Industrial Strategy. Indeed, digital ambition by introducing continuous emission monitoring and vehicle connectivity in PO3a can ensure the reduction of emission over vehicles' lifetimes.

That way, the new Euro 7 standards can be considered as key element to deliver on a zero-pollution ambition as set out by the Communication on the European Green Deal and to contribute to the objectives of the EU's clean air policy, including the planned **revision of the Ambient Air Quality Directives (AAQD)[191] and the existing National Emission reduction Commitments Directive (NECD)[192]**. The commitment in the European Green Deal to "revise air quality standards to align them more closely with the World Health Organization recommendations" supports a high degree of ambition in source legislation such as Euro 7. By ensuring a reduction of all relevant air pollutant emissions from road transport consistent with AAQD/NECD air pollutant coverage and targets, the Euro 7 standards notably support Member States in meeting their commitments under the NECD. This is made in a similar way as the CO_2 emission standards support Member States in meeting their CO_2 targets under the Effort Sharing Regulation[193]. PO2b with the highest emission reductions, in particular for lorries/buses, offers the highest level of coherence with air quality policies, closely followed by PO2a and PO3a. The cumulative impact with the planned revision of the AAQD in 2022 cannot be calculated in this impact assessment but is estimated limited.

---

[191] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12677-Air-quality-revision-of-EU-rules_en

[192] NECD is not planned for a revision in the short term.

[193] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013

Whereas the **CO_2 emission standards** promote zero-emission technologies, such as electric vehicles, the new Euro 7 standards address the emission of harmful air pollutants from combustion engines, brakes and, in the future, tyres with the aim to protect human health and the environment. Therefore the Euro 7 general objectives remain valid insofar as the important share of ICE vehicles will continue to emit exhaust pollutants, and all vehicles will contribute to non-exhaust emissions irrespectively of the engine. Despite proposed end-date of 2035 for new combustion-engine cars/vans, the number of vehicles placed on the market with combustion engines (including hybrids) remain important, in particular for lorries/buses. Both CO_2 emission and Euro pollutant standards are considered as complementary to reach the climate and zero-pollution ambition of the European Green Deal and contribute to the shift to sustainable mobility. All policy options are in principle coherent with this approach, but PO1 to a rather limited extent, given the lower expected pollutant emission reductions.

The **cumulative investment challenge for the automotive sector to reach the climate and zero-pollution ambition** was already recognised in the European Green Deal, which stated that "Delivering additional reductions in emissions is a challenge. It will require massive public investment and increased efforts to direct private capital towards climate and environmental action, while avoiding lock-in into unsustainable practices. […] This upfront investment is also an opportunity to put Europe firmly on a new path of sustainable and inclusive growth. The European Green Deal will accelerate and underpin the transition needed in all sectors." Clear regulatory signals to the automotive sector are considered crucial for delivering climate and zero-pollution investment decisions. As shown in section 7.1, the cumulative investment attributable to PO2a and PO3a are considered not too high, while the investment attributable to PO2b is considered high. As the regulatory costs are expected to be passed on to consumers, the assessment of the cumulative consumer affordability comes to the same result.

The **Roadworthiness Directives** aim at detecting over-polluting light- and heavy-duty vehicles due to potential technical defects by means of periodic testing and inspections and roadside inspections. All policy options contain elements to support this objective, with PO3a introducing effective continuous emission monitoring mechanisms and contributing the most. Significant further cost savings are expected for PO3a in the cars/vans as well as lorries/buses segments due to such more effective continuous emission monitoring mechanisms. Such mechanisms could gradually become a primary tool in the Roadworthiness Directives, modernise the current inspection procedures and lead to lower administrative costs. While this cumulative impact could not be quantified yet in this impact assessment, it shall be part of the upcoming revision of the Roadworthiness Directives.

7.4 Proportionality

PO1: Low Green Ambition

The results from the previous sections illustrate that while PO1 is the least costly for industry, both for cars/vans and lorries/buses, it is simultaneously the least effective in achieving the objectives. PO1 is only expected to achieve significant success towards the first specific objective of reducing complexity of the current Euro emission standards. In particular, the simplification measures introduced in PO1 and continued throughout the other options lead to moderately positive regulatory cost savings for industry (covering costs for testing, witnessing of tests by type-approval authorities and type-approval fees as well as administrative costs for reporting and other information obligations as part of the type-approval procedures). Since PO1 is considered to be not more effective than the baseline in updating obsolete emission limits and only slightly more effective in improving control of real-world emissions, PO1 would only lead to minimal health and environmental benefits for citizens.

The low net benefits in PO1, especially for lorries/buses, point towards an overall low efficiency compared to other options. This indicates that this option is significantly less worthwhile as a whole than the other options.

In addition, the policy option does not improve coherence with the green and digital ambition of the European Green Deal or with other main EU rules tackling air pollutants in the road transport sector (air quality legislation and CO_2 emission standards). Still, some improvements on the coherence with Roadworthiness Directives are expected in PO1.

Considering the above, the low intensity and ambition level of PO1 are not found to match the identified problems and objectives for cars/vans and even less so for lorries/buses, for which the share of new zero- and low-emission vehicles in the fleet is projected to increase at a slower pace. Therefore, PO1 is considered a rather disproportionate policy option.

PO2a: Medium Green Ambition

Where PO1 scores poorly on effectiveness, efficiency and coherence, PO2a scores significantly better on all aspects. In PO2a the higher pressure on regulatory costs for industry is expected to have a moderately negative impact for cars/vans and low negative impact for lorries/buses. Subsequently, a low negative impact on consumer affordability is expected for cars/vans and on affordability for SME users for lorries/buses. Nevertheless, PO2a is more effective in achieving the defined objectives. Since it includes the same simplification measures as PO1, it is equally successful towards the specific objective of reducing complexity. Next to that, PO2a goes significantly beyond PO1 when it comes to the second specific objective of providing up-to-date limits for all relevant air pollutants with only PO2b being more effective. Also for the third specific objective, PO2a goes further than PO1 by extending the durability to the average lifetime of the vehicle and covering medium ambitious real-driving testing conditions. That way, PO2a would lead to the same regulatory cost savings for industry as PO1, while adding medium positive health and environmental benefits for citizens in case of cars/vans and even high positive health and environmental benefits in case of lorries/buses. In addition, PO2a would enable a low positive impact on competitiveness by maintaining for industry access to international key markets.

In contrast to PO1, PO2a is estimated to lead for cars/vans to sufficient net benefits and for lorries/buses to very high net benefits. This difference can be explained by the higher margin for emission reductions possible in HDV. Hence, PO2a is considered an efficient policy option. The assessment of an alternative set of medium-ambitious durability requirements has shown no important change in efficiency for PO2a, while the alternative set of medium-ambitious emission limits has illustrated slightly lower efficiency (see 7.2).

In addition, PO2a improves coherence with other EU policies to a certain extent. It improves coherence with the green ambition of the European Green Deal, the air quality policies, and the CO_2 emission standards, especially for lorries/buses, as it contributes complementary to reach the green and climate ambition of the European Green Deal and the shift to sustainable mobility. The cumulative impacts with CO_2 emission standards on industry and citizens in terms of investments needs and consumer affordability are expected not too high. PO2a also improves coherence with Roadworthiness Directives to the same extent as in PO1.

Considering the above, the medium intensity and ambition level of PO2a are found to match the identified problems and objectives for cars/vans and even more so lorries/buses, for which there is a higher margin for emission reductions. Hence, PO2a is considered a proportionate option, especially in comparison to PO1.

PO2b: High Green Ambition

While PO2b is similarly effective in achieving the objectives as PO2a, it does so at significantly higher cost leading to a higher negative impact for industry compared to PO2a, especially for cars/vans. Subsequently, a medium negative impact on consumer affordability is expected for cars/vans and on affordability for SME users for lorries/buses. Still, PO2b is considered for the cars/vans as well as the lorries/buses segments as most effective regarding the second specific objective of providing up-to-date limits for all relevant air pollutants. While achieving the same regulatory cost savings for industry as PO1 and PO2a due to same simplification measures, PO2b does achieve a higher health and environmental benefits for citizens than both for cars/vans due to the reduction of harmful particles emission from brakes. For lorries/buses, however, these benefits are of the same magnitude as in PO2a. For all vehicles, PO2b would enable a low positive impact on competitiveness by maintaining for industry access to international key markets such as PO2a.

In contrast to PO2a, for PO2b cars/vans the regulatory costs are estimated in the same range as its benefits due to the still high costs for brake filters. For this reason, this policy option is measured to lack efficiency as illustrated by the insufficient net benefits in Table 13. For lorries/buses, the observation is different with PO2b still achieving high net benefits which are however estimated at a lower level than in PO2a and PO3a.

Still, PO2b is expected to be overall the most successful is improving coherence with the green ambition of the European Green Deal, the air quality policies and the CO_2 emission standards, especially for lorries/buses, as it has the highest ambition towards sustainable mobility. However, the cumulative impacts with CO_2 emission standards on industry and citizens in terms of investments needs and consumer affordability are expected high. PO2b also improves coherence with Roadworthiness Directives to the same extent as in PO1 and PO2a.

The high intensity and ambition level of PO2b are still found to match the identified problems and objectives for lorries/buses (at lower extent than PO2a and PO3a), but this cannot be said about PO2b for cars/vans. PO2b for cars/vans is considered disproportionate due to the not sufficient net benefits. PO2b for lorries/buses is considered less proportionate than PO2a and PO3a due to the lower net benefits and some negative impact on affordability for SME users.

PO3a: PO2a and Medium Digital Ambition

While PO3a is as effective as PO2a when it comes to the second specific objective of providing up-to-date limits for all relevant air pollutants, PO3a is found to be the most effective for achieving the other specific objectives. PO3a is most suitable to reduce complexity through continuous emission monitoring. In particular, continuous emission monitoring equipment is expected to simplify the reporting and other information provision obligations for granting of type-approval and ease the verification testing procedures. Subsequently, PO3a achieves the highest cost savings during the implementation phase and administrative costs not only for lorries/buses, but also for cars/vans. In addition, PO3a is also expected to achieve simplifications in the implementation of interlinked Roadworthiness Directive (see below). Also when it comes the third specific objective, PO3a is found to be the most effective to improve control of real-world emissions for all vehicles, even in view of the end-date of 2035 for combustion-engine cars/vans.

At an only slightly higher regulatory cost for industry than in PO2a through increased equipment costs for all vehicles following the introduction of continuous emission monitoring, PO3a is set out to achieve slightly higher health and environmental benefits for citizens. In PO3a, high emitting vehicles are expected to be fixed earlier, while tampering of vehicles should be avoided. Moreover, the additional regulatory costs are for a large part outweighed by the additional regulatory cost savings expected in PO3a over PO1, PO2a and PO2b during the implementation phase and administrative costs. While PO3a leads to similar low negative impacts on affordability for consumers and SMEs as PO2a, it is set out to outweigh the other options when it comes to positive effects on competitiveness by improving for industry access to international key markets and innovation. In particular, the development of sensors and digital communication systems creates market opportunities, some of them beyond the automotive supply-chain. The use of best available sensors supports access to international key markets, in particular to United States and China where similar developments are taking place.

While PO3a surpasses PO2a when it comes to effectiveness, for efficiency the options achieve similar results. When focussing solely on the quantifiable costs and benefits, PO3a scores sufficiently for cars/vans as it achieves net benefits that are equal to those estimated in PO2a. Also for lorries/buses, PO3a is found to be clearly efficient with high net benefits in the ranges of PO2a. Still, PO3a is likely to have additional qualitative benefits for all vehicles exceeding those in PO2a: a more positive impact on competitiveness (see above) and additionally on free movement within the single market, consumer trust and employment/skills (see Table 9 for light-duty vehicles / Table 10 for heavy-duty vehicles).

Overall, PO3a is found to be most coherent with other EU policies. When it comes to coherence with the air quality policies, PO3a is expected to achieve similar results as PO2a. In the context of geo-fencing, new business models using the information collected in PO3a can be developed to support the concept of Smart Cities in the EU and therefore benefit further air quality. PO3a allows for improvements over PO2a in the coherence with the green and digital ambitions of the European Green Deal through the introduction of continuous emission monitoring which contributes to the digital transformation.

When it comes to coherence with the CO_2 emission standards, PO3a is expected to achieve similar results as PO2a, while the relevant cumulative impacts with CO_2 emission standards on industry and citizens are expected not too high.

In addition, continuous emission monitoring in PO3a would allow for an ambitious revision of the Roadworthiness Directives in which a modernisation of inspection procedures to control emissions from vehicles periodically can be put forward. Although out of the scope of this impact assessment, this modernisation in inspections will likely lead to additional cost savings for the competent authorities by reducing the time needed to perform inspections. Such indirect positive impacts will likely also be felt by vehicle owners.

Considering the above, the medium intensity and ambition level of PO3a, adding digital to the green ambition compared to PO2a, are found to match in the best manner the identified problems and objectives for cars/vans and even more so lorries/buses, for which there is a higher margin for emission reductions. Hence, PO3a is clearly found to be a proportionate option.

In summary, PO1 is considered a rather disproportionate policy option, for light- and heavy-duty vehicles. PO2a and PO3a are both considered as proportionate, for light- and heavy-duty vehicles. The additional effectiveness, efficiency and coherence of PO3a over PO2a, for light- and heavy-duty vehicles, is mainly due to its positive impact on competitiveness through the introduction of continuous emission monitoring and its additional coherence with the green and digital ambitions of the European Green Deal and the Roadworthiness Directives. This makes PO3a the most proportionate policy option. PO2b, on the other hand, is considered disproportionate for light-duty vehicles due to the not efficient net benefits and less proportionate than PO2a and PO3a for heavy-duty vehicles due to the lower net benefits and some negative impact on affordability for SME users.

8 PREFERRED OPTION

The overall proportionality assessment of the effectiveness, efficiency and coherence of each of the options has demonstrated in section 7.4 that the policy options can be narrowed down to preferred **medium-ambitious PO3a, for light- and heavy-duty vehicles**. PO3a comprises simplification measures, medium ambitious pollutant emission limits, real-driving testing conditions and durability provisions and introduction of continuous emission monitoring with available sensors for all vehicles. **All arguments below are equally valid for light- and heavy-duty vehicles.**

In addition, the assessment of an alternative set of medium-ambitious durability requirements in Annex 8 (summarized in section 7.2) has shown no important change in efficiency compared with PO3a, while the alternative set of medium-ambitious pollutant emission limits has illustrated slightly lower efficiency.

Although PO3a and PO2a have about the same average net benefit as well as different net benefits for cars/vans and lorries/buses (about €25 billion in PO3a and PO2a for cars/vans, about €117 billion in PO3a and PO2a for lorries/buses), there are further qualitative benefits of PO3a in terms of effectiveness, efficiency and coherence leading to the overall conclusion that PO3a is most proportionate for both vehicle segments. Moreover, there is a clear need to act in both vehicle segments to improve our health and well-being.

PO3a is most **effective** in achieving all defined objectives, for light- and heavy-duty vehicles. It provides up-to-date limits for all relevant air pollutants and is most suitable to reduce complexity of the current Euro 6/VI emission standards and to improve comprehensively control of real-world emissions by introducing continuous emission monitoring and extending the durability requirements to the average lifetime of the vehicle.

PO3a is **cost-efficient** by reaching, as PO2a, highest health and environmental benefits for citizens at lowest total regulatory costs for industry and would lead to less than 1% vehicle price increase for small petrol cars/vans. Despite the proposed end-date of 2035 for combustion-engine cars/vans, PO3a is estimated to lead for cars/vans to sufficient net benefits in average of €25 billion and for lorries/buses to very high net benefits in average of €117 billion (see quantitative efficiency assessment in Table 13). This difference between light- and heavy-duty vehicles can be explained by the higher margin for emission reductions possible for lorries/buses.

Nevertheless, also acting for cars/vans is essential for achieving the green ambition of the European Green Deal, Zero Pollution Action Plan and new EU Urban Mobility Framework to make transport drastically less polluting, especially in cities. These net benefits cannot be ignored or assessed less relevant, since the PO3a technologies are available for the cars/vans segment and the necessary investments of €300 per car/van can be recouped until 2035. In addition, sensors for vehicles are designed for application in all vehicles. With great numbers of combustion cars/vans still being brought on the market until 2035, introducing PO3a for all vehicles will allow for economies scale from which the heavy-duty segment will still be able to profit, even after 2035.

PO3a is likely to have additional qualitative efficiency benefits for all vehicles exceeding those in PO2a: some positive impacts on competitiveness by improving for industry access to international key markets and innovation, on the single market by possibly preventing Member States from taking unilateral decisions to address excessive emissions from road transport, on consumer trust by providing reliable information on emission performance of vehicles and on employment and re- and up-skilling of workforces.

PO3a is found to be to be most **coherent** with other EU policies. It is coherent with the air quality legislation and CO_2 emission standards. PO3a ensures a cost-efficient reduction of all relevant air pollutant emissions from light- and heavy-duty vehicles, supporting Member States in meeting their emission reduction commitments under the National Emission reduction Commitments Directive and contributing complementary to reach the GHG reduction objectives of the EU. The cumulative impacts with CO_2 emission standards on industry and citizens in terms of investments needs and consumer affordability are expected not too high.

In addition, PO3a ensures highest coherence with the European Green Deal and the current and planned revision of the Roadworthiness Directives. It adds digital ambition to PO2a through introducing continuous emission monitoring in line with the twin green and digital transformation aimed at by the European Green Deal. While having the same net benefits, PO3a goes significantly beyond PO2a by adding the advantages of continuous emission monitoring. These advantages are valid for light- and heavy-duty vehicles:

- PO3a is expected to achieve the highest administrative, testing and type-approval cost savings, as continuous emission monitoring equipment is expected to facilitate the granting of type-approval and the verification testing procedures, which almost balance the additional equipment costs. These cost savings are higher for light- than for heavy-duty vehicles.

- PO3a would offer the possibility of geo-fencing which would support Member States and cities improving air quality in densely populated areas. This technology puts a plug-in hybrid electric vehicle automatically into zero-emission mode when entering zero-emission zones, such as cities. This would allow for the development of new business models using the emission information collected to support the concept of Smart Cities in the EU.

- Continuous emission monitoring introduced by PO3a would also be beneficial as monitoring indicator for a mid-term evaluation under the European Green Deal. The air pollution modelling tools used in this impact assessment could move from limited test data to real world data.

- PO3a is expected to introduce effective continuous emission monitoring which is likely to become a primary testing method for checking the environmental compliance of vehicles. As such, it would help modernising inspection procedures to periodically control the actual emission performance of vehicles under the Roadworthiness Directives, which would allow to fix high emitting vehicles earlier and avoid tampering of vehicles. This is expected to lead to significant cost savings and health and environmental benefits that were not taken into consideration in this impact assessment. If option PO3a were not to be retained, the possibilities for the revision of the Roadworthiness Directives will be significantly limited.

From the stakeholder consultations, there is a pressure from environmental and consumer organisations and some Member States to set more ambitious requirements as in PO3a and PO2b to support further improvement in air quality and thus contribute to protecting public health and the environment. However, automotive industry has raised strong concerns in the stakeholder consultations regarding the technological potential for reducing emissions as proposed in PO2b. In particular, the question if the NO_x emission limits for cars could be reduced to a value lower than 30 mg/km and if high ambitious real-driving testing boundaries ("free driving") should be introduced led to high stakeholder interest in Euro 7. Manufacturers' concerns have been taken into account in the design of the policy options by differentiation of emission limits, real-driving testing boundaries and durability requirements and extensively discussed in AGVES meetings. In fact the proportionality assessment agrees with some of the concerns, such as the marginal gains of going to values lower than 30 mg/km for NO_x proposed in PO3a and that boundaries of testing need to be reasonable leading to PO2b being disproportionate for cars/vans.

During the consultation activities, stakeholders from Member States, component suppliers, civil society and citizens expressed their support for including the completely new continuous emission monitoring, as considered in PO3a, as an important action to measure real world emissions and to guarantee transparency and protection from tampering. Concern of making pollutant data from vehicles available was not raised by consumer organisations or citizens in the stakeholder consultations. These findings illustrate that new continuous emission monitoring is generally found to be socially acceptable. However, vehicle manufacturers were more reluctant on the matter, primarily indicating the need for independent technology and equipment for continuous emission monitoring to prevent high costs and risk for their international competitiveness. Still, the results of the cost analysis in section 6.3.1 illustrate that the cost for available sensor technology is counterbalanced by higher costs savings due to the expected simplified type-approval.

The main consumer organisation and some automotive manufacturer and Member States estimated in the targeted stakeholder consultation that even though more stringent pollutant limits will have an impact on the vehicle price, it will also make battery electric vehicles even more competitive. This potential accelerated shift to electric vehicles by medium-ambitious Euro 7 has been taken into account in the modelling of the CO_2 impact assessment for cars and vans[32] by common econometric modelling of the projected vehicle fleet (see Figure 7) and looking into the net benefits for high CO_2 target level taking into account other policies including stricter PO3a pollutant limits (see Annex 4, Figure 14 and 15).

Automotive industry also raised concerns regarding competitiveness in view of the investments that need be focussed on the climate ambition of the European Green Deal, in particular in view of the proposed end-date for combustion-engine cars and vans. The investment challenge for the automotive sector to reach the climate and zero-pollution ambition was already recognised in the European Green Deal. The impact assessment shows that the investment attributable to PO3a is not high. With the end-date of combustion-engine cars/vans by 2035, the cumulative annual investment of PO3a and CO_2 emission standards amounts to €20.2 billion, out of which €19 billion is due to the proposed CO_2 target and €1.2 billion due to PO3a. Furthermore, the analysis of the cumulative CO_2 and PO3a investments also shows that there are benefits for the competitiveness of the automotive industry for zero- and low-emission technologies which will both be more and more demanded on the global market.

In conclusion, the preferred option for Euro 7 is medium-ambitious PO3a, for light- and heavy-duty vehicles.

9 HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

The Euro 6/VI evaluation identified as lesson learnt the lack of monitoring indicators in the Euro 6/VI emission standards[83]. Arrangements should be made to monitor and evaluate the effectiveness of Euro 7 emission standards against operational objectives and to establish causality between the observed outcomes and the legislation. For this purpose, a number of monitoring indicators are proposed for the review of Euro 7 emission standards planned with the mid-term evaluation of the ‘fit-for-55’ initiatives.

Table 14 – Operational objectives and respective monitoring indicators for the preferred policy option 3a

Operational objectives	Monitoring indicators
Simplify the Euro emission standards	• Number of emission type-approvals under Euro 7 per vehicle type • Costs during implementation phase and administrative costs per emission type approval
Provide appropriate air pollutant limits for road transport	• Proof of improved control of emissions under all conditions of use for all regulated pollutants • Enforcement costs, including costs for infringements and penalties in case of non-compliance and monitoring costs
Enhance emission control over the vehicles’ lifetime	• Evolution of emissions over the lifetime of vehicles as evidenced by appropriate testing campaigns and continuous emission monitoring

The review of Euro 7 emission standards will also evaluate a set of more general indicators from other EU air pollutant policies for road transport:

- Annual pollutant concentration levels in Europe’s urban areas and annual share of road transport to the pollutant emissions as reported by the Member States to the EEA under the National Emission reduction Commitments Directive (NECD)[28] and included in the annual report on air quality in Europe[1].

- Annual number of registered vehicles and share of powertrain technologies on EU roads as reported by the Member States to the European Alternative Fuels Observatory.[108]
- Annual development of impacts of air pollution on health (i.e. premature deaths related to exposure of certain pollutants) as included in the annual report on air quality in Europe.
- Annual share of road transport to the pollutant emissions of certain pollutants as reported by the Member States to the EEA under the NECD.
- Annual number of notifications received from Member States for barriers of internal EU trade of cars, vans, lorries/buses caused by technical prescriptions imposed by national, regional or local authorities (i.e. bans of any kind) under the notification procedure of Directive 2015/1535[194].

[194] Directive (EU) 2015/1535 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services; see also 2015/1535 notification procedure