BRIEFING

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Emission reductions and public health benefits from timely Euro 7 standards

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BACKGROUND

In November 2022, the European Commission (EC) released its proposed Euro 7 regulation for light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs).[1] This regulation will establish new emission limits for pollutants detrimental to human health, such as nitrogen oxides (NOx) and particulate matter (PM). Nearly a decade has passed since Europe last updated emission limits under Euro 6/VI. While emission control systems have advanced since then,[2] a lack of further regulation has hindered the widespread adoption of these technologies in the vehicle market. Meanwhile, Europe ranks third globally in transportation-attributable air pollution deaths, after China and India.[3] The Euro 7 proposal could reduce ambient air pollution and the consequent number of premature deaths, especially in urban areas.

However, the proposal has been contentious for many reasons. First, it sets emission limits for LDVs below the least ambitious policy option considered in the impact

1 European Commission, "Proposal for a Regulation of the European Parliament and of the Council on Type-Approval of Motor Vehicles and 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 § (2022), https://ec.europa.eu/transparency/documents-register/api/files/COM(2022)586_0/090166e5f39c64d8?rendition=false. LDVs are defined as passenger cars and light trucks and vans with a gross vehicle weight less than 3.5 tonnes. HDVs are defined as trucks and vans with a gross vehicle weight above 3.5 tonnes, and all buses and coaches.

2 Pierre-Louis Ragon, *Estimated Cost of Diesel Emission Control Technology to Meet Euro 7 Standards for Heavy-Duty Vehicles*, (Washington, DC: ICCT, 2023), https://theicct.org/publication/euro7-hdv-costs-jul23/.

3 Susan C. Anenberg et al., "The Global Burden of Transportation Tailpipe Emissions on Air Pollution-Related Mortality in 2010 and 2015," *Environmental Research Letters 14*, no. 9 (September 2019): 094012, https://doi.org/10.1088/1748-9326/ab35fc.

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assessment accompanying the proposal.[4] While emission limits for HDVs broadly align with cutting-edge global standards, the proposal for LDVs only makes Euro 6 emission limits application- and fuel-neutral by aligning all vehicles with current Euro 6 limits for gasoline vehicles.

Second, opposition to the proposal has formed in the European Parliament and the Council of the European Union, with some calling for reduced stringency. As of May 2023, a draft proposal from the Parliament's Environment (ENVI) Committee, which has purview over the Euro 7 proposal, has sought to lower emission thresholds for HDVs, relax test conditions for both LDVs and HDVs, and delay the introduction of the standards by up to 5 years.[5] On the Council side, eight Member States (including France and Italy) have signed a non-paper[6] in favor of completely scrapping the Euro 7 regulation.[7]

A reoccurring argument against the proposed Euro 7 standards which has driven attempts to erode its stringency stems from the existing and proposed CO_2 standards, which require both LDVs and HDVs to gradually phase out the sale of internal combustion engine (ICE) vehicles. ICE-powered LDVs can be sold until 2035 under current standards; proposed CO_2 standards for HDVs would require a 90% reduction in the CO_2 emissions of most trucks and buses by 2040. The phase out for LDVs would not come into effect for 12 years and the 90% HDV target would not apply for 17 years. During those years, ICE vehicles would continue to be sold. However, manufacturers could more rapidly meet Euro 7 standards by integrating emission control systems with their existing ICE assembly lines, even as they undertake a longer-term technology shift to zero-emission vehicles.

If adopted as proposed, Euro 7 standards will be introduced in 2025 for LDVs and 2027 for HDVs. From these years of implementation, approximately 58 million conventional LDVs will be sold through 2035 and 3 million conventional HDVs will be sold through 2050.[8] Fewer Euro IV and Euro V vehicles combined were sold than Euro 7 HDV sales projected under the existing proposal (Figure 1). Thus, the investments required to meet Euro 7 will be spread out over similar sales volumes as previous iterations of Euro standards. Due to the phase out targets set for LDVs, a volume of vehicles roughly half of those regulated under Euro 6 will be regulated under Euro 7. However, the technologies needed to conform with Euro 7 are already available and require little additional investment to bring to market.

4 European Commission, "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," November 10, 2022, https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2022)359&lang=en.

5 Committee on the Environment, Public Health and Food Safety, "Draft Report on the Proposal for a Regulation of the European Parliament and of the Council on Type-Approval of Motor Vehicles and 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)0586 – C9-0375/2022 – 2022/0365(COD))," 2022, https://www.europarl.europa.eu/doceo/document/ENVI-PR-746876_EN.pdf.

6 A non-paper is an informal document issued to help negotiations.

7 "Non-Paper of Bulgaria, Czechia, France, Hungary, Italy, Poland, Romania and Slovakia on the Proposal of New Vehicle Emission Standards EURO 7," 2023, 7, https://www.eunews.it/wp-content/uploads/2023/05/Non-paper-on-Euro7-proposal-2.pdf.

8 Based on modeling described further in this briefing.

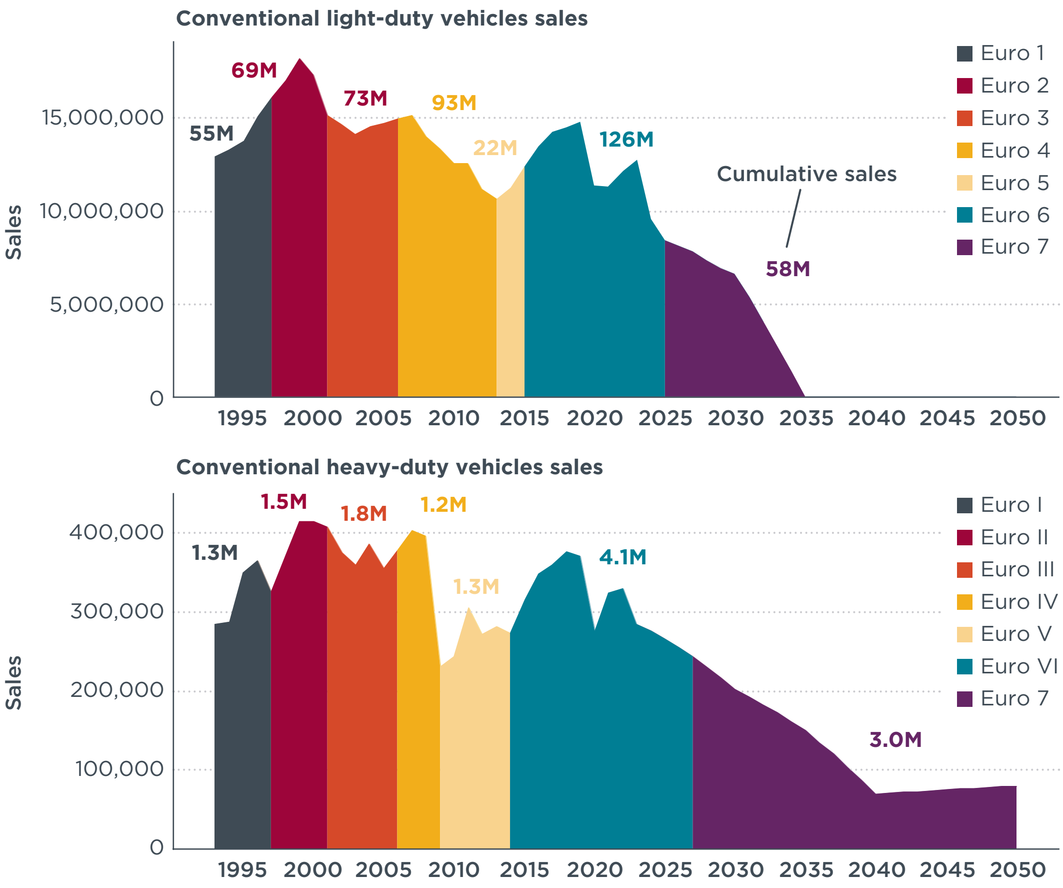

Figure 1. Sale of conventional light- and heavy-duty vehicles by Euro class.

Furthermore, LDVs and HDVs in Europe have average respective lifetimes of 18 and 20 years.[9] ICE vehicles sold in the lead up to their phase-out dates will thus continue to operate and emit pollutants for several decades beyond their phase-out dates.

This briefing updates two previous ICCT analyses[10] to show the emission reductions and resultant health benefits of the timely adoption of the Euro 7 proposal, the additional benefits of adopting more stringent emission limits, and the risks of delaying the standards in line with the recommendations from the ENVI committee.

9 Georg Bieker, *A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars*, (Washington, DC: ICCT, 2021), https://theicct.org/publication/a-global-comparison-of-the-life-cycle-greenhouse-gas-emissions-of-combustion-engine-and-electric-passenger-cars/; Eamonn Mulholland Joshua Miller, Caleb Braun, Arijit Sen, Pierre-Louis Ragon, and Felipe Rodríguez, *The CO_2 Standards Required for Trucks and Buses for Europe to Meet Its Climate Targets*, (Washington, DC: ICCT, 2022), https://theicct.org/publication/hdv-co2standards-recs-mar22/.

10 Eamonn Mulholland, Joshua Miller, Yoann Bernard, Kaylin Lee, and Felipe Rodríguez, *The Role of NO_x Emission Reductions in Euro 7/VII Vehicle Emission Standards to Reduce Adverse Health Impacts in the EU27 through 2050, Transportation Engineering 9* (September 2022): 100133, https://doi.org/10.1016/j.treng.2022.100133; Eamonn Mulholland, Josh Miller, Caleb Braun, Lingzhi Jin, and Felipe Rodríguez, *Quantifying the Long-Term Air Quality and Health Benefits from Euro 7/VII Standards in Europe*, (Washington, DC: ICCT, 2021), https://theicct.org/publication/quantifying-the-long-term-air-quality-and-health-benefits-from-euro-7-vii-standards-in-europe/.

MODELING FRAMEWORK AND ASSUMPTIONS

We model NO_x emission reductions using the ICCT's Roadmap model.[11] Reductions are converted into changes in the number of premature deaths using a dedicated health impact model—the Fast Assessment of Transport Emissions (FATE).[12] We apply the same modeling methodology as the two previous studies focused on the health impacts of Euro 7.[13] This analysis adds to these previous works by updating scenarios based on the Euro 7 proposal and modeling the degradation of emission control systems under the durability requirements delineated in Euro 6/VI and Euro 7 and described in the next section.

SCENARIO DESCRIPTION

We model emissions reductions and health benefits under four scenarios:

1. *Euro 6 baseline*: Applying the most recent iteration of Euro 6/VI to all vehicles through 2050.
2. *Euro 7 proposal*: Adopting the EC's proposed Euro 7 standards compared to emissions projected under current Euro 6/VI standards.
3. *Euro 7 increased stringency*: Increasing the stringency of Euro 7 standards beyond the EC's proposal.
4. *Euro 7 delay*: Delaying the proposal's adoption up to 5 years, in line with the recent amendments proposed by the ENVI committee.

All scenarios account for the effect of CO_2 standards on ICE vehicle registration numbers.

The health benefits of the *Euro 7 proposal* and *increased stringency* scenarios are calculated relative to the *Euro 6 baseline*, a case where LDVs compliant with Euro 6e and HDVs compliant with Euro VI-E will be sold through 2050.[14] Emissions and health impacts of a 1–5 year delay are calculated relative to the Euro 7 proposal, thus showing the marginal impact a delay would have on the proposal's benefits. Emissions factors for Euro 6e and Euro VI-E vehicles are based on measurements from remote sensing campaigns to reflect real-world emissions levels.[15]

All scenarios apply the same level of zero-emission vehicle penetrations; for LDVs, we use sales rates outlined by the International Energy Agency's Announced Pledges Scenario,[16] which models the technology deployment required under the adopted CO_2 standards for cars and vans in Europe.[17] For HDVs, we apply the targets outlined from

11 International Council on Clean Transportation, "Roadmap v1.8 Documentation," Roadmap Model Documentation, accessed June 22, 2022, https://theicct.github.io/roadmap-doc/versions/v1.8/.

12 International Council on Clean Transportation, "Fast Assessment of Transportation Emissions (FATE) Model Documentation," 2021, https://theicct.github.io/FATE-doc/versions/v0.3/.

13 For details on methodology, see *Mulholland, Miller, Bernard, Lee, and Rodríguez, The Role of NOx Emission Reductions in Euro 7/VII Vehicle Emission Standards to Reduce Adverse Health Impacts in the EU27 through 2050 and Mulholland, Miller, Braun, Jin, and Rodríguez, Quantifying the Long-Term Air Quality and Health Benefits from Euro 7/VII Standards in Europe*.

14 Since Euro 6e will only apply from September 2023, measurement-based real-world emissions factors for Euro 6e were not readily available for this analysis and were instead derived from Euro 6d values and applying the conformity factor of 1.1 which is required under Euro 6e.

15 Mulholland, Miller, Bernard, Lee, and Rodríguez, *The Role of NO_x Emission Reductions in Euro 7/VII Vehicle Emission Standards to Reduce Adverse Health Impacts in the EU27 through 2050*.

16 "Announced Pledges Scenario (APS) – Global Energy and Climate Model – Analysis," International Energy Agency, accessed July 4, 2023, https://www.iea.org/reports/global-energy-and-climate-model/announced-pledges-scenario-aps.

17 LDV CO_2 standards agreement: A 55% and 50% reduction in the emissions of new cars and vans respectively by 2030, and 100% by 2035

our recent analysis of the proposed CO_2 standards.[18] For city buses, the target is 100% by 2030.[19] Figure 2 shows the resulting sales shares.

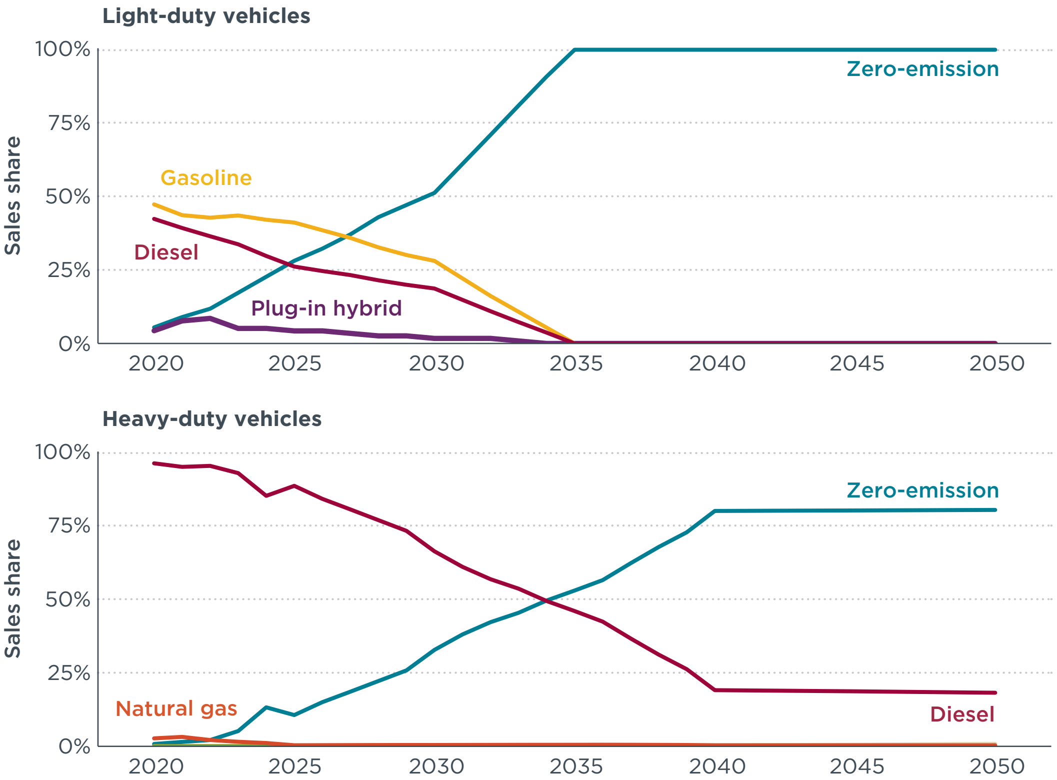

Figure 2. Projected sales share of light- and heavy-duty vehicles by powertrain.

For the *Euro 7 proposal* scenario, which models the EC's proposal, we apply the durability requirements and NO_x emission limits as outlined by the proposal.[20] For the *increased stringency* scenario, we apply the policy option PO2a/PO3a for LDVs and PO2b for HDVs from the impact assessment accompanying the proposal[21] and extend the durability requirements. For both scenarios, we assume that Euro 7 applies from 2025 for LDVs and 2027 for HDVs.

Tables 1 and 2 describe the emissions factors and durability requirements for each scenario. Appendix A offers further details.

18 Eamonn Mulholland and Felipe Rodríguez, *An Analysis of the Revision of Europe's Heavy-Duty CO_2 Standards*, (Washington, DC: ICCT, 2023), https://theicct.org/publication/europe-heavy-duty-vehicle-co2-standards-may23/. HDV CO_2 standards proposal: a 43% reduction in the emissions in most new trucks and all coaches by 2030, 64% by 2035, and 90% by 2040.

19 European Commission, "Proposal for a Regulation of the European Parliament and of the Council Amending Regulation (EU) 2019/1242 as Regards Strengthening the CO_2 Emission Performance Standards for New Heavy-Duty Vehicles and Integrating Reporting Obligations, and Repealing Regulation (EU) 2018/956," *Official Journal of the European Union*, February 14, 2023, https://climate.ec.europa.eu/system/files/2023-02/policytransporthdv20230214proposalen0.pdf.

20 There are several elements of the proposal which fall beyond the scope of this analysis, including battery durability requirements, brake particle emissions, on-road driving requirements, and evaporative and refueling emissions.

21 European Commission, "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."

Table 1. Emission limits and durability requirements for the LDV scenarios.

	Euro 6e baseline	Euro 7 proposal	Euro 7 increased stringency
NO_x real-driving not-to-exceed emission limit[a] (mg/km)	66-138[b]	66	33
Normal lifetime emission limits apply	≤100,000 km or 5 years	≤ 160,000 km or 8 years	≤ 200,000 km or 10 years
Extended lifetime, 20% less stringent emission limits apply		≤ 200,000 km or 10 years	≤ 240,000 km or 15 years

[a] Takes into account the conformity factor for real-driving emission tests.;
[b] Range indicates different limits for different engine technologies, fuel types and applications (cars, small and large vans)

Table 2. Emission limits and durability requirements for the HDV scenarios.

	Euro VI-E baseline		Euro 7 proposal		Euro 7 increased stringency	
	Cold	Hot	Cold[a]	Hot[a]	Cold[a]	Hot[a]
NO_x (mg/kWh)	460		350	90	175	90
PM (mg/kWh)	10		12	8	12	8
Normal lifetime emission limits apply	≤700,000 km or 7 years		≤700,000 km or 15 years		≤700,000 km or 15 years	
Extended lifetime, 20% less stringent emission limits apply			≤875,000 km		450,000 km for light trucks[b] 560,000 km for medium trucks[b] 1.1 million km for heavy trucks[b]	

[a] We apply a weight of 14% to cold start and 86% to hot start emissions, in line with the EC's accompanying impact assessment;
[b] Light trucks are defined as having a gross vehicle weight less than 7.5 tonnes, medium trucks between 7.5 and 16 tonnes, and heavy trucks above 16 tonnes.

EMISSION BENEFITS OF EURO 7 SCENARIOS

As Figure 3 shows, under the *Euro 6 baseline* scenario, we project a total of 8.9 million tonnes of NO_x would be emitted by LDVs from 2025 to 2050 and 3.1 million tonnes by HDVs from 2027 to 2050. The dark sections of the figure show the emissions that could be affected by Euro 7. For LDVs, 1 million tonnes of NO_x would be emitted by vehicles sold in or after 2025. For HDVs, 830,000 tonnes of the 3.1 million tonnes total would be emitted by vehicles sold in or after 2027.

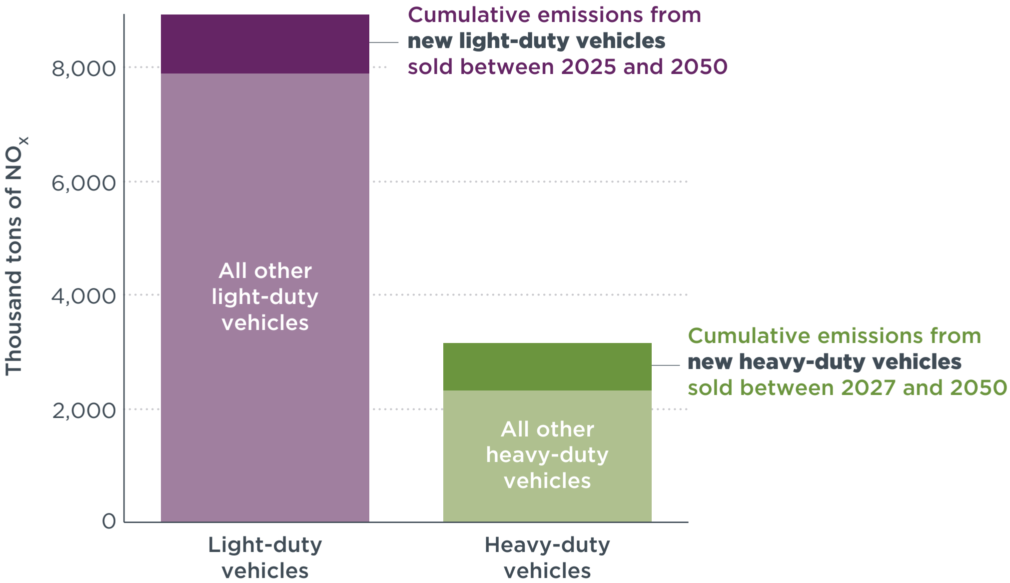

Figure 3. Projected cumulative NO_x emissions from the entire vehicle fleet under the Euro 6 baseline scenario from 2025 to 2050 for LDVs and 2027 to 2050 for HDVs.

Figure 4 shows each scenario's impact on emissions from new vehicles (shown in dark purple and green in Figure 3). The proposed Euro 7 regulation would reduce these cumulative NO_x emissions from LDVs sold from 2025 onwards by 36%. These benefits are limited in part due to the expected electrification of the sector, but also due to the limited stringency of the proposal. Increasing the stringency of the standards in line with policy option PO2a/PO3a of the accompanying impact assessment and extending durability requirements (see Table 1) would increase the cumulative NO_x reduction for LDVs to 70%.

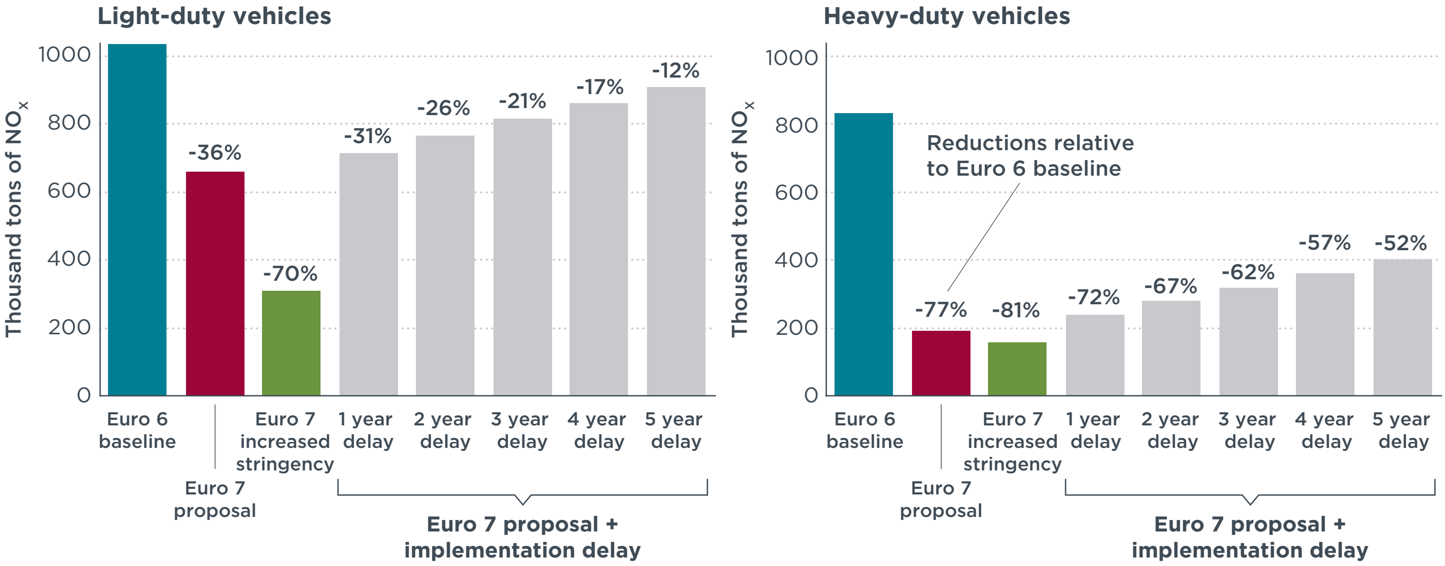

Figure 4. Projected cumulative tonnes of NO_x emissions from LDVs sold in or after 2025 (left) and HDVs sold in or after 2027 (right) for each scenario. Data labels show the percent change in emissions relative to the Euro 6 baseline.

The projected emission benefits of Euro 7 are higher for HDVs than LDVs. This is because the Euro 7 proposal is more stringent for HDVs and the rate of HDV electrification is projected to be slower. Under the Euro 7 proposal, cumulative NO_x emissions from HDVs are projected to be reduced by 77% relative to the Euro 6 baseline. The benefits of increased stringency are less pronounced for HDVs than for the LDV proposal, because emissions factors under the Euro 7 proposal for HDVs are closer to those of the PO2a/PO3a policy option than for LDVs. Aligning with this more stringent policy option would increase the cumulative NO_x emission reductions for HDVs to 81%.

As shown in Figure 4, delaying the implementation of Euro 7 might weaken its efficacy. The later Euro 7 is implemented, the fewer vehicles it will affect. During every year of a delay, conventional vehicles would be type approved and sold under Euro 6 instead of Euro 7 standards, which would lead to increased emissions over the lifetime of these vehicles. An amendment proposed by the ENVI committee would delay the implementation of Euro 7 for new LDV type approvals by 3 years after the regulation's adoption and 5 years for HDVs. Assuming Euro 7 standards are adopted in 2024, this proposal would see the standards taking in effect in 2027 for LDVs and 2029 for HDVs.[22]

Such a delay for LDVs would reduce the emission benefit from 36% to 26%, relative to the Euro 6 baseline. A 5-year delay for LDVs would reduce the emission benefit to 12%. For HDVs, each year of delay would reduce the cumulative NO_x emission benefit by approximately 5%. A delay in line with the proposal by the ENVI committee would reduce the Euro 7 benefit from a 67% reduction in cumulative NOx emissions to 52% relative to the Euro 6 baseline.

22 The implementation date for HDVs is thus already considered to have a 2-year delay in the proposal.

SENSITIVITY ANALYSIS

To account for uncertainty in the technology pathways which HDV manufacturers might follow in complying with CO_2 standards, we conducted a sensitivity analysis.

The proposed HDV CO_2 standards introduce a threshold which allows trucks and buses to have a low level of emissions and still be classified as zero-emission.[23] This allowance would enable hydrogen combustion engine vehicles to be classified as zero-emission. While mono-fuel hydrogen combustion vehicles have no tailpipe CO_2 emissions, their combustion cycle results in the formation of NO_x. We assessed the potential impact of this allowance on the cumulative NO_x emissions under the *Euro 6 baseline* and *Euro 7 proposal* scenarios through a sensitivity analysis. This analysis evaluated a worst-case scenario in which all tractor-trailers with a gross vehicle weight above 16 tonnes are converted to hydrogen combustion powered vehicles instead of battery electric to comply with the proposed CO_2 standards.

The cumulative emissions under a *Euro 6 baseline* scenario which allows hydrogen combustion vehicles would result in 3.4 million tonnes of cumulative NO_x emissions between 2027 and 2050, compared to 3.1 million tonnes in the absence of hydrogen combustion technologies. The *Euro 7 proposal* under the hydrogen combustion scenario would reduce these cumulative NO_x emissions to 2.5 million tonnes, while under the scenario lacking the technology, cumulative NO_x emissions would be reduced to 2.4 million tonnes.

Despite the uncertainty surrounding the mix of technologies that will be deployed to comply with CO_2 targets, implementing Euro 7 standards would limit the potential for adverse effects of hydrogen combustion engines on air pollution.

For LDVs, the CO_2 standards foresee exceptions for ICE vehicles running exclusively on CO_2-neutral fuels.[24] These vehicles will continue to generate pollutant emissions. As details of the implementing regulation are not yet known, uncertainty exists regarding the role of these vehicles. We therefore assumed all LDVs after 2035 to be zero-emission vehicles.

PREMATURE DEATHS AVOIDED UNDER EURO 7 SCENARIOS

The patterns for the health benefits of various Euro 7 scenarios are similar to those for NO_x emissions (see Figure 5). Compared to the *Euro 6 baseline*, the *Euro 7 proposal* scenario would avoid 7,200 premature deaths from LDVs and HDVs combined through 2050. Appendix B details country-specific results on premature deaths avoided.

23 Eamonn Mulholland and Felipe Rodríguez, *An Analysis of the Revision of Europe's Heavy-Duty CO_2 Standards*, (Washington, DC: International Council on Clean Transportation, May 22, 2023), https://theicct.org/publication/europe-heavy-duty-vehicle-co2-standards-may23/.

24 Jan Dornoff, *CO_2 Emission Standards for New Passenger Cars and Vans in the European Union*, (Washington, DC: ICCT, 2023), https://theicct.org/publication/eu-co2-standards-cars-vans-may23/.

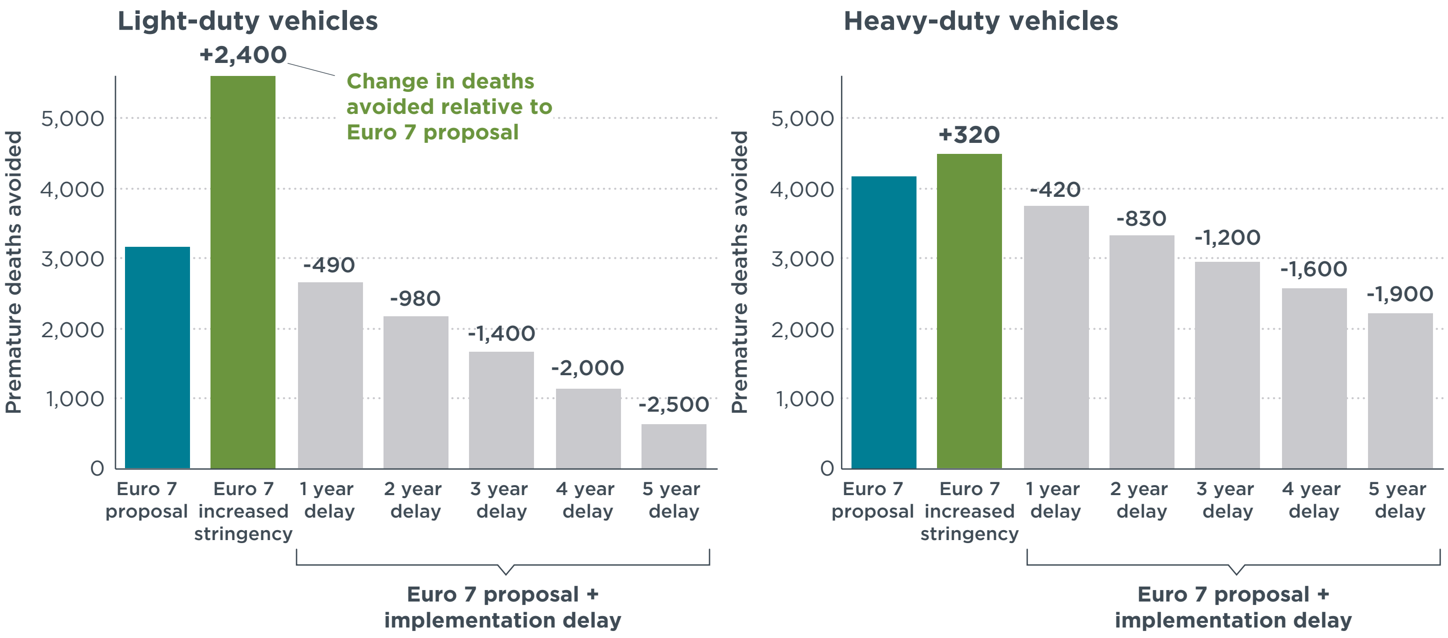

Figure 5. Projected cumulative premature deaths avoided compared to the Euro 6 baseline scenario for LDVs (left) from 2025 to 2050 and HDVs (right) from 2027 to 2050 for each scenario. Data labels show the change in avoided premature deaths relative to the Euro 6 baseline.

As shown in Figure 5, the health benefits of the *increased stringency* scenario are nearly double those of the *Euro 7 proposal* scenario, avoiding an additional 2,400 premature deaths. For HDVs, the *increased stringency* scenario avoids 320 premature deaths in addition to the 4,100 premature deaths avoided by the *Euro 7 proposal* scenario.

Delaying Euro 7 by one year compared to the *Euro 7 proposal* scenario would lead to 490 additional premature deaths from LDV emissions and 420 premature deaths due to HDV emissions. A delay in line with that proposed by the ENVI committee would increase the number of premature deaths by 980 from LDV emissions and 830 from HDV emissions.

CONCLUSIONS

The Euro 7 proposal would deliver substantial emission reductions and public health benefits if adopted and implemented in a timely manner. Despite the growing rise in the sales of zero-emission vehicles, over 58 million conventional LDVs and 3 million conventional HDVs will be sold between the proposed implementation dates of Euro 7 through 2050; these vehicles will remain on the roads for more than a decade. The timely implementation of Euro 7 would minimize the air pollution contributed by these vehicles and reduce the associated public health burden. This analysis modeled emission reductions and health benefits from implementing Euro 7 as proposed and with increased stringency; it also considered the lesser benefits associated with delays. Three main conclusions emerge from this analysis:

Implementing the EC's proposal for Euro 7 will bring significant benefits, especially for HDVs. The Euro 7 proposal would avoid approximately 1 million tonnes of NO_x from LDVs and HDVs through 2050. That would avoid 36% of projected NO_x emissions from LDVs sold from 2025 onwards and 77% of projected NO_x emissions from HDVs sold from 2027. These reductions would avoid 7,200 premature deaths until 2050, with 56% attributed to the HDV Euro 7 proposal.

Delaying the introduction of Euro 7 will have a detrimental health effect. Each year of implementation delay would lead to approximately 900 additional premature deaths; a delay in line with the proposals from the ENVI committee in the European Parliament would lead to an additional 1,800 premature deaths.

Increasing the stringency of the proposal would bring additional health benefits. Added stringency could avoid totals of 5,500 premature deaths from LDV emissions and 4,400 premature deaths from HDV emissions (that is an additional 2,400 LDV-associated premature deaths avoided and additional 320 HDV-associated premature deaths avoided). The additional benefits for LDVs are larger since the current proposal is comparatively less stringent (see Figure 4). These benefits can be achieved by aligning emission limits and durability requirements of Euro 7 with the more stringent policy options evaluated by the impact assessment accompanying the proposal (see Tables 1 and 2).

Furthermore, Euro 7 would ensure improved air quality even if ICE vehicles running on CO_2 neutral fuels and hydrogen combustion engines are applied in large scale.

The timely deployment of Euro 7 emission standards, particularly with increased stringency for LDVs, can substantially reduce harmful emissions from road transport and, consequently, the number of premature deaths caused by air pollution.

APPENDIX A: SCENARIO ASSUMPTIONS

This section provides a more detailed description to the assumptions we apply to the four scenarios presented in this paper:

1. Euro 6 baseline
2. Euro 7 proposal
3. Euro 7 increased stringency
4. Euro 7 delay

Euro 6 baseline. We apply emissions factors for every Euro emission class based on real-world emissions data recorded during remote sensing campaigns. For LDVs, we assume that every vehicle sold between 2024 and 2050 is certified to the Euro 6e regulatory requirements. For HDVs, we assume that between 2022 and 2050 only Euro 6 VI-E vehicles are sold. We derive the emissions factors of both LDVs and HDVs from remote sensing data to represent on-road vehicle emissions. However, since Euro 6e takes effect from September 2023, measurements were not available for this analysis and were instead derived from Euro 6d values. For this purpose, we assume implementation of the Euro 6e emission stage for all LDVs, meaning that Euro 6 emission limits continue to apply but the more stringent Euro 6e conformity factor,[25] compared to Euro 6d, is considered. For Euro 6d vehicles, the conformity factor for NO_x emissions is 1.43, while it is reduced 23% to 1.1 for Euro 6e vehicles. If tailpipe emissions reduce by a similar level, we derive Euro 6e real-world emissions factors by reducing the Euro 6d real-world emissions factors by 23%.

The effect of vehicle aging on NO_x emission performance is replicated in the model by applying an age dependent multiplier, as shown in Figure A1, and derived as follows. Euro 6d NO_x emissions factors available from remote sensing campaigns are largely based on measurements of vehicles that are less than 1 year old. Emission compliance of Euro 6d vehicles can be verified for 5 years. We therefore assume these vehicles are still compliant at the end of this 5-year period. Consequently, due to the aging of the emission control system, emissions of new vehicles must be lower than the limit. This is reflected in data from remote sensing campaigns showing real-world NO_x emissions factors of new Euro 6d vehicles being, on average, about 11%–14% lower than the real-world limit.[26] On this basis, we conservatively consider an average annual emissions factor deterioration rate of 2%, resulting in about 10% higher emissions after 5 years than for the new vehicle. In absence of enforceable durability requirements beyond an age of 5 years, we expect an accelerated deterioration of the emission control system, assuming a linear annual degradation of 7.5%, up to a maximum aging multiplier of 1.7 after 13 years. These annual aging multipliers are applied to the Euro 6e emissions factors of new vehicles to arrive at the development of the emissions factors over the vehicle lifetime.

25 With Euro 6e, the conformity factor was renamed as the portable emissions measurement system (PEMS) margin. The conformity factor was introduced by the EC to account for uncertainties of emission measurements when performing real-driving emission (RDE) tests (i.e., tests on public roads outside of controlled laboratory conditions). For simplicity, we use the term conformity factor.

26 Remote sensing data from additional campaigns performed until 2021 were considered when determining the Euro 6d NO_x emissions factor.

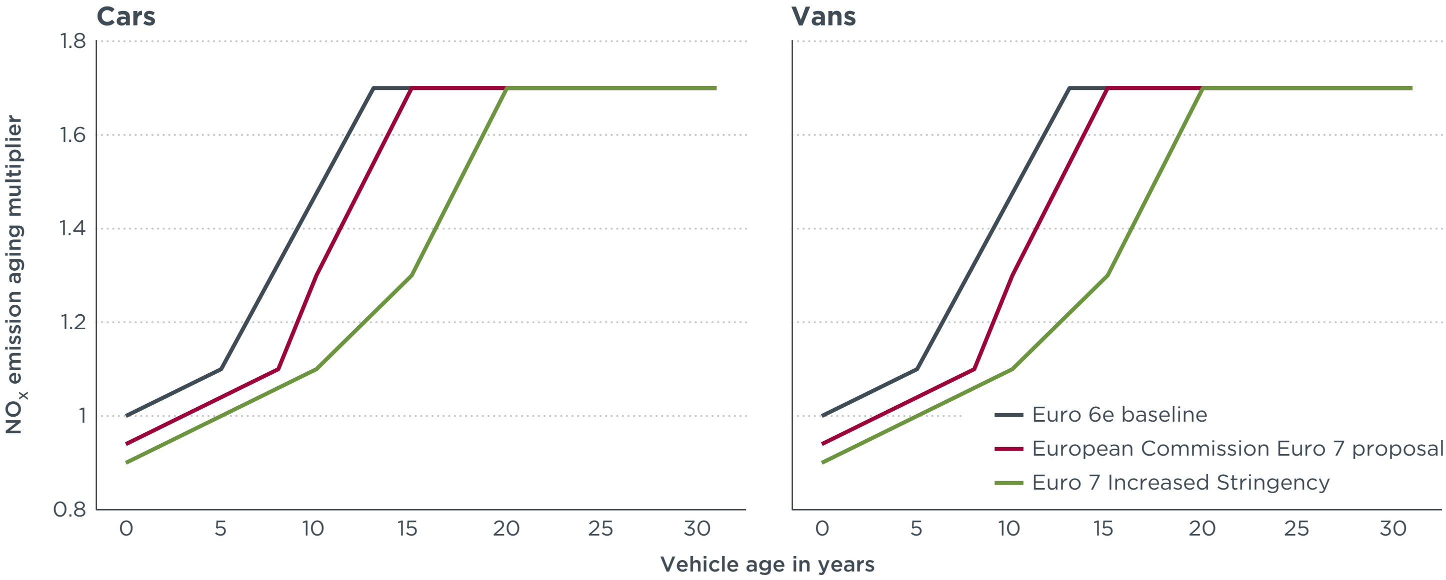

Figure 1A. Vehicle age-dependent NO_x emission deterioration multipliers applied for the three emission durability requirement scenarios. A vehicle is expected to be fully emission compliant until an aging multiplier of 1.1. Based on this presumption, the aging multiplier of a new vehicle is derived by considering an annual deterioration of 2% until the aging multiplier of 1.1 is reached.

Euro 7 proposal. While different emission limits applied under Euro 6/VI, depending on fuel type and vehicle category, the Euro 7 proposal sets the same emission limits for all LDVs and HDVs.[27] For LDVs, Euro 7 only tightens the NO_x emission limits for vans and all diesel vehicles to match the current Euro 6 petrol passenger car limit. As it is unclear if a PEMS margin will be applied under Euro 7,[28] we conservatively assume that the Euro 6e factor for NO_x emissions of 1.1 will remain. Therefore, we modeled this scenario by using the Euro 6e emissions factors of petrol passenger cars as described above for all vehicles, regardless of fuel type or category. For HDVs, we applied the percentage differences in limits between Euro VI and the proposed Euro 7 values to those obtained from remote sensing campaigns.

In the Euro 7 proposal for LDVs, the lifetime in which full emission compliance is required was extended from 5 to 8 years, as shown in Table 1. For HDVs, it was increased from 7 to 15 years. As explained for the Euro 6e baseline scenario, vehicles are expected to be compliant if their NO_x emissions are up to 10% higher than the emissions factor for new vehicles. On this basis, we derive an annual aging rate of 2% and apply it to both LDVs and HDVs. Under the assumption that the same aging rate applies and to achieve the same emissions factor after 8 instead of 5 years, the emissions factor of new Euro 7 vehicles must be lower than for Euro 6e vehicles. Therefore, under this scenario, we calculate the emissions factor of new Euro 7 vehicles as 0.94 times the emissions factor of a new Euro 6e petrol passenger car. For Euro 7 vehicles at the end of their normal lifetime, the emissions factor is multiplied by 1.1.

The Euro 7 proposal also introduces an extended lifetime that applies once the vehicle has exceeded the normal lifetime of up to 10 years for LDVs, and up to a mileage of 875,000 km for HDVs. Within this extended lifetime, gaseous pollutant emissions may be up to 20% higher than the Euro 7 limit. We therefore assume that after the limit is reached, emissions factors are about 20% higher than under the normal lifetime. In combination with the above-mentioned assumption that emissions factors at the end of the normal life are 1.1 times that of a new Euro 6e petrol car, we derive the emissions factor at the end of the extended lifetime by multiplying the

27 Only for under-powered vans, a higher emission limit applies. This is not considered in this briefing.
28 See note 24.

same emissions factor by 1.3. After the end of the extended lifetime, we apply the same linear degradation of 7.5 percentage points until the maximum of 1.7 is reached after 15 years.

For HDVs, the durability requirements are also modeled in line with the proposal, assuming no deterioration until the end of the normal lifetime of the vehicle of the lesser of 15 years or 700,000 km mileage. An additional lifetime of 875,000 km is also applied. Between the normal and the additional lifetime, a factor will be applied to the emission limits that vehicles will be required to comply with as an in-service conformity. This factor, which has yet to be defined, we assume to be 1.5. We assume a linear increase to this factor between the normal and additional lifetime. Once the additional lifetime is reached, there are no requirements for the vehicle to comply and we assume a constant factor of 1.5 applied to the Euro 7 emission limits.

Euro 7 increased stringency. This scenario models the effect of increasing the stringency of the EC's proposed Euro 7 based on the policy option recommended by the Euro 7 impact assessment. This scenario applies a NO_x emission limit to all vehicles of 50% of the Euro 6 limit for petrol passenger cars. For HDVs, we assume the hot emission limits are the same as under the most ambitious proposal identified in the impact assessment, but the cold emission limits are 50% lower. To reflect this in our model for this scenario, we reduced the NO_x emissions factor of a vehicle at the end of its normal life by 50% compared to the *Euro 7 proposal* scenario.

To account for the average age of LDVs in the EU and to align with international best practice, we assume for this scenario a normal lifetime of 10 years and an extended lifetime of up to 15 years, based on the outcome of an earlier ICCT Euro 7 assessment.[29] Using the same approach as described for the *Euro 7 proposal* scenario, we adjusted the aging multiplier curve to reflect the emissions factor deterioration over time. With a 2% emissions factor deterioration rate for a new vehicle until the end of its normal lifetime, NO_x emissions of a new Euro 7 vehicle are calculated to be about 18 percentage points lower than the emissions of a vehicle at the end of its normal lifetime. At the end of the extended lifetime, emissions are assumed to be about 20% higher than at the end of the normal lifetime. Beyond the extended lifetime, the same aging rate of 7.5 percentage points is applied, up until a maximum aging multiplier of 1.7.

For HDVs, we model increasing the stringency of the standards to align with the highest ambition considered by the Impact Assessment, policy option PO2b.[30] We also model an increase the durability requirements to align with those used by the U.S. Environmental Protection Agency, that is about 450,000 km for HDVs with a gross vehicle weight (GVW) less than 7.5 tonnes, 560,000 km for HDVs with a GVW between 7.5 and 16 tonnes, and 1.1 million km for HDVs with a GVW above 16 tonnes.

Euro 7 delay. This scenario applies the same assumptions as the *Euro 7 proposal* scenario, but introduced up to 5 years later. The *Euro 7 proposal* scenario assumes that Euro 7 will apply to LDVs from 2025 and HDVs from 2027. The delay scenarios consider a later implementation date of up to 2030 for LDVs and 2033 for HDVs.

29 Jan Dornoff, *How to Make Euro 7 More Effective: An Analysis of the European Commission's Proposal for Light- and Heavy-Duty Vehicles*, (Washington, DC: ICCT, 2023), https://theicct.org/publication/euro7-analysis-recommendations-jan23/.

30 European Commission, "ANNEXES to the Proposal for a Regulation of the European Parliament and the Council on Type-Approval of Motor Vehicles and 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 § (2022), https://ec.europa.eu/transparency/documents-register/api/files/COM(2022)586_1/090166e5f39c64bb?rendition=false.

APPENDIX B: COUNTRY SPECIFIC HEALTH IMPACTS

Table 1B. Cumulative premature deaths avoided per Member State for each scenario relative to the Euro 6 baseline (2027–2050).

Country	Euro 7	Euro 7 Increased Stringency	1-year delay	2-year delay	3-year delay	4-year delay	5-year delay
AUT	157	261	166	143	121	99	77
BEL	152	259	159	135	111	87	64
BGR	37	56	41	36	31	26	21
CYP	1	2	1	1	1	1	1
CZE	252	399	266	230	194	160	126
DEU	1,513	2,647	1,604	1,366	1,130	899	674
DNK	83	152	91	78	65	52	39
ESP	409	718	438	378	316	255	194
EST	6	9	6	5	5	4	3
FIN	18	30	20	17	14	11	9
FRA	846	1,481	897	762	628	493	360
GRC	18	30	20	18	15	13	11
HRV	79	126	84	72	61	50	39
HUN	161	248	172	149	126	104	83
IRL	16	27	17	14	12	9	7
ITA	827	1,407	869	743	618	494	371
LTU	48	68	49	43	37	31	25
LUX	6	10	6	5	4	3	3
LVA	28	39	28	24	21	17	14
MLT	1	2	1	1	1	1	1
NLD	188	322	198	168	139	109	80
POL	799	1,193	850	745	642	540	442
PRT	30	43	30	25	21	16	12
ROU	147	222	165	145	125	106	88
SVK	105	160	112	98	84	70	56
SVN	38	60	40	35	29	24	19
SWE	54	98	59	50	41	33	25