

The revised CO₂ standards for heavy-duty vehicles in the European Union

Eamonn Mulholland

On May 13, 2024, the Council of the European Union ratified the agreement on the revision of the CO₂ standards for heavy-duty vehicles (HDVs). This marks the final step in the legislative process, following successful negotiations with the European Commission and the European Parliament. The latter had already adopted the negotiated agreement on April 10, 2024. The original CO₂ standards required the emissions from most new trucks to be 15% lower by 2025 and 30% lower by 2030 compared to the 2019 reporting period.¹ The revision widens the scope of vehicles covered to include more truck types, buses, coaches, trailers, and vocational vehicles; increases the stringency of the targets; and adjusts the flexibilities available to manufacturers for compliance. It maintains the 2025 CO₂ reduction target of 15% and raises the 2030 target to 45%, while introducing a 65% reduction target for 2035 and a 90% target for 2040. It is currently one of the most ambitious greenhouse gas standards for the heavy-duty vehicle sector globally.

This policy update summarizes the main elements of the revised CO₂ standards.

POLICY BACKGROUND

The original CO₂ standards for heavy-duty vehicles were adopted in 2019. They obligated manufacturers of certain truck classes, which represented 65% of heavy-duty vehicle sales in 2023,² to reduce their emissions by 15% by 2025 and 30% by 2030 relative to the 2019 reference period.

The European Climate Law, which entered into force in 2021, requires that the EU achieve climate neutrality by 2050.³ The transport sector is obligated to reduce its

¹ Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 Setting CO₂ Emission Performance Standards for New Heavy-Duty Vehicles and Amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC, Official Journal of the European Union (OJ) L 198/202 (July 25, 2019), <http://data.europa.eu/eli/reg/2019/1242/oj/eng>. The 2019 reporting period runs from July 1, 2019 to June 30, 2020.

² Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023.

³ Regulation (EU) 2021/1119 of the European Council and the Parliament of 30 June 2021 Establishing the Framework for Achieving Climate Neutrality and Amending Regulation (EC) No 401/2009 and (EU) 2018/1999 (European Climate Law), OJ L 243/1 (July 9, 2021), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119&from=EN>.

www.theicct.org

communications@theicct.org

[@theicct.org](https://twitter.com/theicct.org)

icct
THE INTERNATIONAL COUNCIL
ON CLEAN TRANSPORTATION

emissions by 90% by 2050 relative to 1990 to comply with this target.⁴ Heavy-duty vehicles were responsible for 28% of CO₂ emissions from the European road transport sector in 2021,⁵ and the absence of further regulations would render the sector unlikely to contribute their share of emission reductions towards this target.

To address the gap between expected HDV CO₂ emissions and the level needed to achieve climate neutrality, on February 14, 2023, the European Commission released a proposal to revise the CO₂ standards.⁶ The proposal was submitted to both the Council of the European Union and the European Parliament. During a meeting of environment ministers on October 16, 2023, the Council approved a general approach that retained the main elements of the Commission's proposal.⁷ The most significant amendments included reductions in proposed targets for city buses and trailers. In a plenary vote on November 21, 2023, the Parliament voted in favor of the main elements of the Commission's proposal while adopting several amendments, including a provision to increase the scope of the regulation to cover both vocational vehicles and certain light trucks with a gross vehicle weight below 5 tonnes (t).⁸ The Parliament also voted in favor of a mechanism whereby vehicles running exclusively on CO₂ neutral fuels, such as e-fuels and biofuels, could be sold by a manufacturer to aid in compliance with the standards.

In the first trilogue meeting on January 18, 2024, representatives of the Commission, Council, and Parliament agreed to a compromise that extends the scope of the regulation to include vocational vehicles from 2035 and reduces targets for buses and trailers, albeit to a lesser extent than in the Council's general approach. Trucks below 5 t were ultimately excluded from the regulation, while the mechanism regarding CO₂ neutral fuels was omitted but left to be considered in a review of the standards required to take place by 2027.

On April 10, 2024, the European Parliament ratified the trilogue agreement. Following this, the Council of the European Union adopted the agreement on May 13, 2024. These milestones complete the legislative process, paving the way for the regulation to be published in the Official Journal of the European Union.

4 European Commission, "EU Sustainable and Smart Mobility Strategy," n.d., <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12438-Sustainable-and-Smart-Mobility-Strategy>.

5 European Environment Agency, *National Emissions Reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism* (October 13, 2023), <https://www.eea.europa.eu/en/datahub/datahubitem-view/3b7fe76c-524a-439a-bfd2-a6e4046302a2>.

6 Proposal for a Regulation of the European Parliament and of the Council Amending Regulation (EU) 2019/1242 as Regards Strengthening the CO₂ Emission Performance Standards for New Heavy-Duty Vehicles and Integrating Reporting Obligations, and Repealing Regulation (EU) 2018/956, *COM/2023/88 final*, February 14, 2023, https://climate.ec.europa.eu/system/files/2023-02/policy_transport_hdv_20230214_proposal_en_0.pdf.

7 Council of the European Union, "Outcome of Proceedings: Proposal for a Regulation of the European Parliament and of the Council Amending Regulation (EU) 2019/1242 as Regards Strengthening the CO₂ Emission Performance Standards for New Heavy-Duty Vehicles and Integrating Reporting Obligations, and Repealing Regulation (EU) 2018/956 – General Approach," October 17, 2023, <https://data.consilium.europa.eu/doc/document/ST-14284-2023-INIT/en/pdf>.

8 European Parliament, "Strengthening the CO₂ Emission Performance Targets for New Heavy-Duty Vehicles: Amendments Adopted by the European Parliament on 21 November 2023 on the Proposal for a Regulation of the European Parliament and of the Council Amending Regulation (EU) 2019/1242 as Regards Strengthening the CO₂ Emission Performance Standards for New Heavy-Duty Vehicles and Integrating Reporting Obligations, and Repealing Regulation (EU) 2018/956 (COM(2023)0088) – C9-0025/2023 – 2023/0042(COD)1," November 21, 2023, https://www.europarl.europa.eu/doceo/document/TA-9-2023-0403_EN.pdf.

KEY ELEMENTS OF THE HEAVY-DUTY VEHICLE CO₂ STANDARDS

SCOPE

The original CO₂ standards applied to trucks with a gross vehicle weight greater than 16 t with either a 4x2 or 6x2 axle configuration. As noted above, these vehicles were responsible for 65% of HDV sales in 2023.

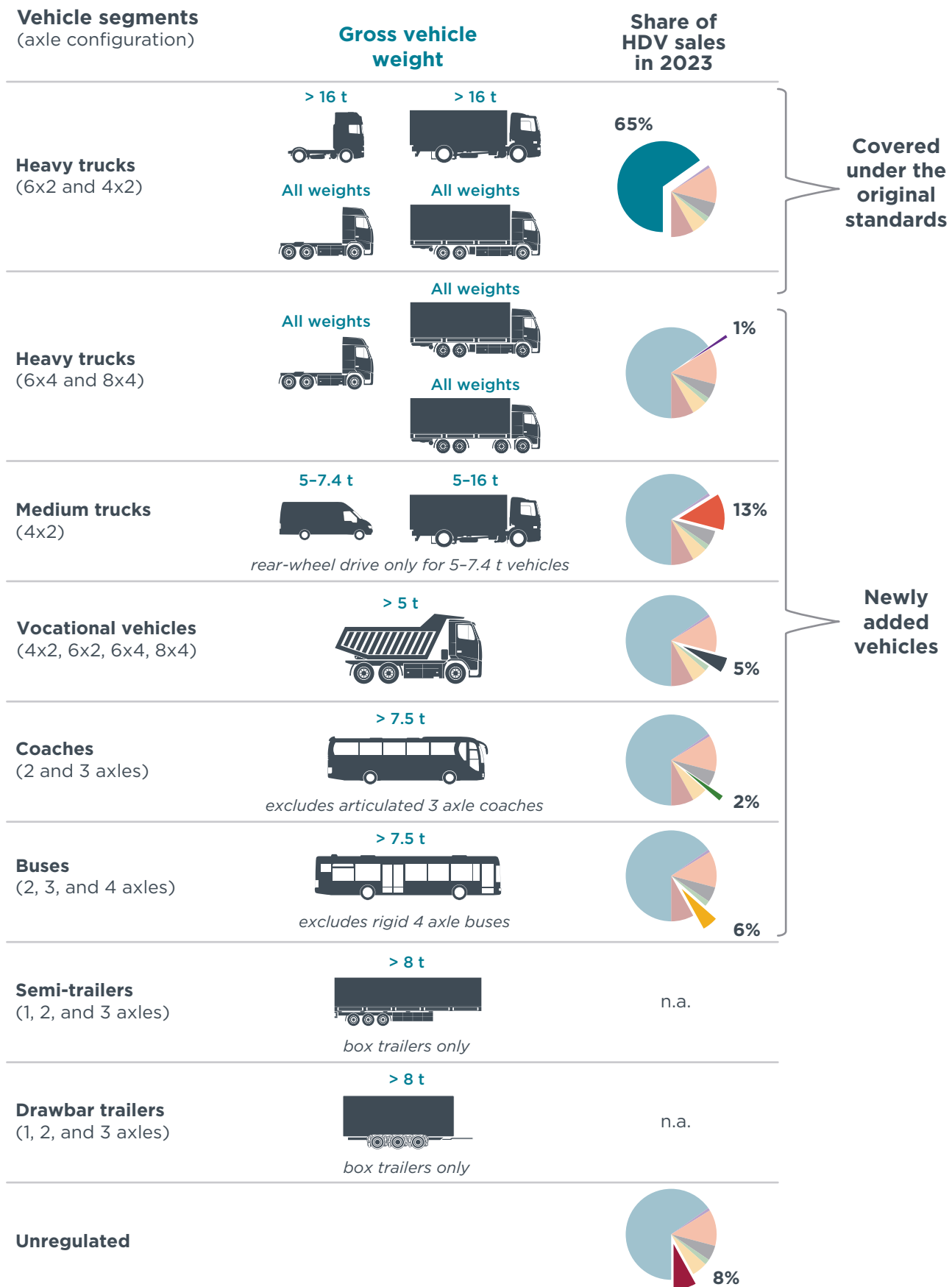
The revised standards extend the scope of vehicles to cover more truck types, buses, coaches, trailers, and vocational vehicles. Combined, heavy-duty vehicles that made up 92% of sales in 2023 are now covered by the CO₂ standards.⁹

Under EU regulations, heavy-duty vehicles are classified into numbered vehicle groups based on characteristics such as gross vehicle weight, axle configuration, and body type. A full list of these vehicle groups and their characteristics is available in the appendix. Figure 1 presents a simplified summary of the vehicle segments covered by the current standards and the new segments covered by the proposal.

⁹ Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023.

Figure 1

Scope of vehicles covered under the CO₂ standards and their annual sales relative to all HDVs



Source: Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION THEICT.ORG

VOCATIONAL VEHICLES

Vocational vehicles are now included in the coverage of the CO₂ standards. These vehicles are broadly defined as not-for-delivery vehicles, such as refuse trucks, tipper trucks, and construction vehicles.¹⁰ Vocational vehicles are the only newly added vehicle segment that do not have a 2030 target; their first target will apply in 2035. Until then, zero-emission vocational vehicles will be reported as non-vocational vehicles with equivalent characteristics to assist manufacturers in achieving their CO₂ emission reduction target.¹¹

TRAILERS

Semi-trailers, drawbar trailers, and center-axle trailers with box body configurations have been added to the CO₂ standards under this revision. Trailers generally do not produce any direct CO₂ emissions because they are usually not motorized. However, they can contribute to reductions in emissions from the motorized trucks that tow them through measures such as aerodynamic improvements, light-weighting, use of low rolling-resistance tires, or deployment of electric propulsion mechanisms. Regulation (EU) 2022/1362 defines the framework under which the CO₂ emissions of a trailer are calculated.¹²

As with trucks, trailer CO₂ emissions are determined based on computer simulations. The emissions of the trailer being towed by a standardized diesel truck are first simulated over the baseline period (discussed below). To comply with the CO₂ emission reduction targets, the trailer manufacturer must then apply efficiency measures to the trailer so that the CO₂ emissions from the standardized diesel truck carrying the improved trailer correspond to the emission reduction targets in the target years.

URBAN BUSES, INTERURBAN BUSES, AND COACHES

All urban buses, interurban buses, and coaches with a gross vehicle weight above 7.5 t have been added to the scope of the CO₂ standards.¹³ Distinctions between these vehicle types are important, as urban buses are regulated through a sales share target for zero-emission vehicles, while coaches and interurban buses are regulated through a CO₂ emissions reduction target.

An urban bus is defined as a vehicle designed for standing passengers to allow frequent passenger movement. An interurban bus is defined as a vehicle designed principally for the carriage of seated passengers, with standing passengers allowed in the gangway or in an area that does not exceed the space provided for two double seats. A coach is defined as a vehicle designed exclusively for seated passengers.¹⁴

EXTRA-HEAVY VEHICLE COMBINATIONS

A new vehicle subgroup will be created through a delegated act to acknowledge the European Modular System, which allows longer and heavier combinations of vehicles.

¹⁰ More specifically, a vocational vehicle is defined as either (i) a heavy-duty vehicle not intended for the delivery of goods that has a bodywork code 1, 9, 10, 15, 16, 18, 19, 20, 23, 24, 25, 26, 27, 28, or 31 (as defined in Appendix 2 of Regulation (EU) 2018/858) or (ii) a tractor with a maximum speed not exceeding 79 km/h.

¹¹ For example, a zero-emission vehicle from group 4v would be reported as a group 4 vehicle until 2035.

¹² Commission Implementing Regulation (EU) 2022/1362 of 1 August 2022 Implementing Regulation (EC) No 595/2009 of the European Parliament and of the Council as Regards the Performance of Heavy-Duty Trailers with Regard to Their Influence on the CO₂ Emissions, Fuel Consumption, Energy Consumption and Zero Emission Driving Range of Motor Vehicles and Amending Implementing Regulation (EU) 2020/683, OJ L 205/145 (August 1, 2022), https://eur-lex.europa.eu/eli/reg_impl/2022/1362/oj.

¹³ Articulated coaches with three or more axles and rigid-body buses with four or more axles are technically exempt. No such vehicles have been sold in Europe in the last decade.

¹⁴ More specifically, an urban bus has a vehicle code of 31-LF, 31-L1, 31-DD, 33-LF, 33-L1, 33-DD, 35-FE, or 39-FE, an interurban bus has a code of 31-L2 or 33-L2, while a coach has a vehicle code of 32-C2, 32-C3, 32-DD, 34-C2, 34-C3, or 34-DD. Table A5 presents the characteristics associated with each of these codes.

This new category will comprise vehicles that have three or more axles, an engine power equal to or greater than 400 kW, and a gross vehicle weight of more than 60 t. Vehicles meeting these criteria represented less than 0.1% of the total sales of heavy-duty vehicles in 2023.¹⁵ This new subgroup will still be subject to the same CO₂ reduction targets as all other trucks.

UNREGULATED VEHICLES

Several categories of heavy-duty vehicles remain unregulated, but each constitute a relatively small share of total annual HDV sales.¹⁶ These include:

- » Trucks and vans with a gross vehicle weight between 3.5 t and 5 t (3.3% of HDV sales in 2023)
- » 4x4 trucks (2.1%)
- » 6x6 trucks (0.4%)
- » 4-axled trucks, excluding 8x4 vehicles (1.0%)
- » 5-axled trucks (0.1%)
- » 4x2 trucks and vans with a gross vehicle weight between 5 t and 7.4 t without rear-wheel drive (0.7%)¹⁷
- » Buses and coaches with a gross vehicle weight less than or equal to 7.5 t (0.5%)

These vehicles are not covered in the Certification Regulation (EU) 2022/1379, which requires manufacturers to monitor and report their emissions.¹⁸ Without being included in the Certification Regulation, these vehicle categories cannot easily be integrated into the CO₂ standards.

EXEMPTIONS

Manufacturers that produce fewer than 100 vehicles in a reporting period, defined as the period from July 1 in the stated year until June 30 of the following year, are exempt from complying with the standards—though they may still opt to be included, which may be beneficial for zero-emission vehicle manufacturers that seek to participate in the vehicle trading system (discussed below). Manufacturers that would receive this exemption accounted for 0.4% of the total sales of heavy-duty vehicles in 2023.¹⁹ If a manufacturer sells fewer than 100 vehicles but is connected to another manufacturer (e.g., if they are owned by the same parent company), and their combined sales are more than 100 vehicles, they will not receive this exemption.

Heavy-duty vehicles registered for use by civil protection services, fire services, forces responsible for maintaining public order, or urgent medical care services are also exempt from the CO₂ emission reduction targets.

15 Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023.

16 Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023.

17 While front-wheel drive vehicles under this category are not included in the CO₂ standards, a zero-emission version can be reported as a vehicle with a rear-wheel drive for the purposes of contributing to a manufacturer's CO₂ emission reduction target.

18 Commission Regulation (EU) 2022/1379 of 5 July 2022 Amending Regulation (EU) 2017/2400 as Regards the Determination of the CO₂ Emissions and Fuel Consumption of Medium and Heavy Lorries and Heavy Buses and to Introduce Electric Vehicles and Other New Technologies, OJ L 212/1 (2022), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R1379&qid=1664295468190&from=en>.

19 Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023.

BASELINE PERIOD

Manufacturers have a common baseline on which CO₂ targets are based. In other words, their targets are not based on the emissions of their own vehicles, but on all vehicles sold by all manufacturers. For every vehicle group, a reference emission level is determined by taking the average emissions of all vehicles sold in the baseline year. For vehicles covered by the original standards, this baseline year was the 2019 reporting period. For newly added vehicles, the baseline year is either the 2021 or 2025 reporting period (see Table 1).

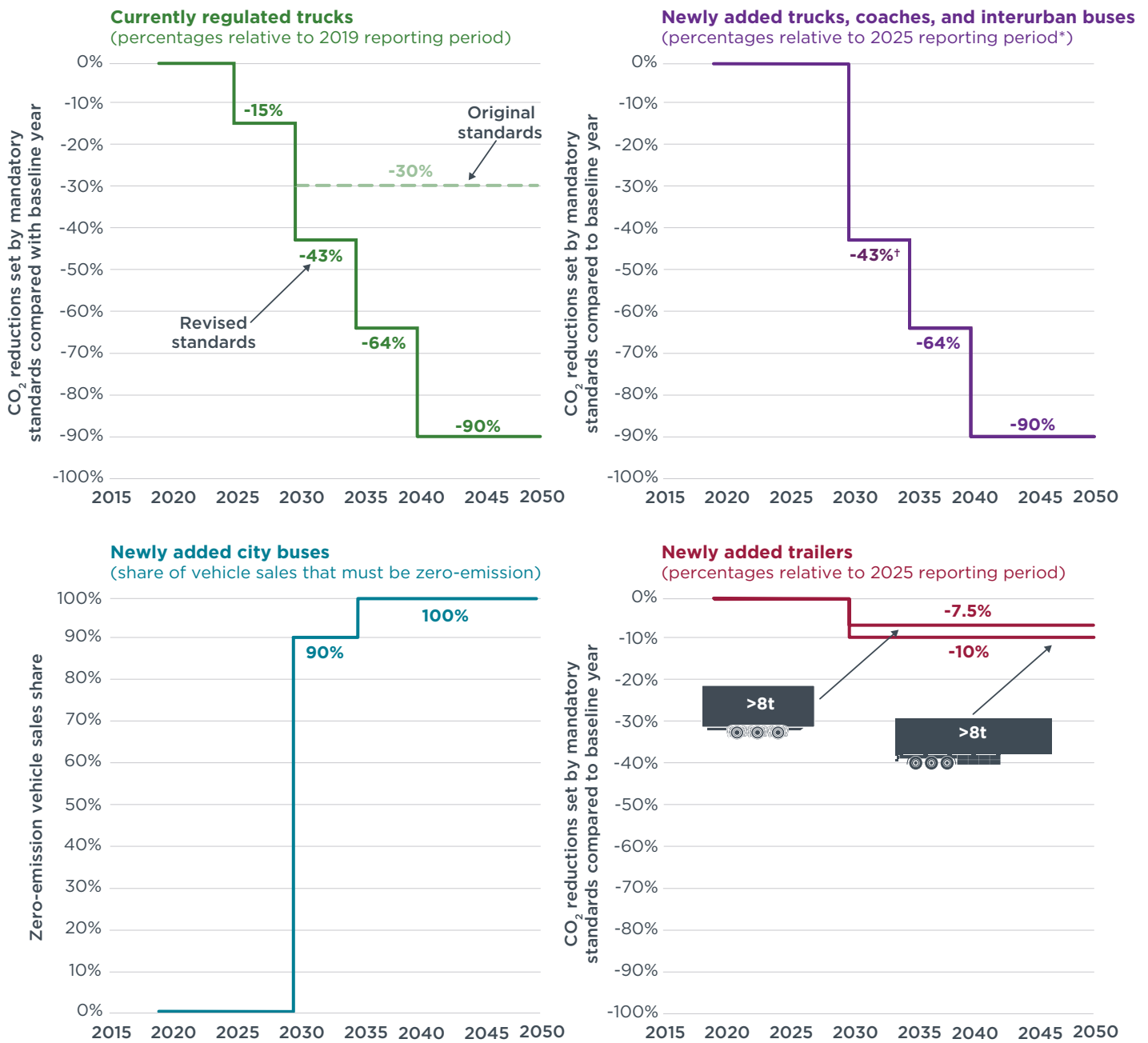
TARGETS

The revision sets targets of a 45% reduction in emissions from the baseline by 2030, a 65% reduction by 2035, and a 90% reduction by 2040. These targets are averaged across all motorized vehicles (i.e., trucks, coaches, and buses) and represent high-level targets to communicate the overall ambition of the standards.

The specific emissions reduction targets for each vehicle segment differ from these average targets, as shown in Figure 2. Trucks and coaches have a 43% reduction target for 2030,²⁰ 64% target for 2035, and a 90% target for 2040. Urban buses have a zero-emission sales share target of 90% in 2030 and 100% in 2035. Semi-trailers and drawbar/center-axle trailers have a 10% and 7.5% CO₂ emission reduction target, respectively, in 2030.

²⁰ Vocational vehicles do not have a 2030 target.

Figure 2
Specific targets for HDVs relative to their reporting period



* The reference period for vehicle groups 1, 2, 3, 11, 12, and 16 is the 2021 reporting period
 † Vocational vehicles do not have a target for 2030

The specific targets are applied to bins of vehicles. Every bin includes multiple vehicle groups based on their characteristics. Table 1 defines these bins, their targets, and the baseline year on which the targets are based (which run from July 1 of the stated year until June 30 of the following year). The description of each vehicle group can be found in the appendix.

Table 1
Vehicle bins, their corresponding groups, vehicle characteristics, and reduction targets by year

	Vehicle bins	Vehicle group	Gross vehicle weight (t)	Axle configuration	2025	2030	2035	2040	Baseline year
Currently regulated trucks	Heavy lorries > 16 t with 4x2 and 6x4 axle configurations	4-UD, 4-RD, 4-LH, 5-RD, 5-LH, 9-RD, 9-LH, 10-RD, 10-LH	> 16	4x2, 6x2	15%	43%	64%	90%	2019
Newly added vehicles	Heavy lorries > 7.4t and ≤ 16 t	1s, ^a 1, 2, 3	> 7.4 – ≤16	4x2	0%	43%	64%	90%	2021
	Heavy lorries with special axle configuration	11, 12, 16	All weights	6x4, 8x4					
	Medium lorries	53, 54	> 5 – ≤7.4	4x2 (rear wheel drive)					
	Coaches and interurban buses	32-C2, 32-C3, 32-DD, 34-C2, 34-C3, 34-DD, 31-L2, 33-L2	> 3.5	2- and 3-axles					2025
	Primary vehicles of coaches and interurban buses	> 3.5	2- and 3-axles						
	Vocational vehicles	53v, 1sv, 1v, 2v, 3v, 4v, 5v, 9v, 10v, 11v, 12v, 16v	> 3.5	4x2, 6x2, 6x4, 8x4					
Newly added trailers	Drawbar/centre-axle trailers ^b	111, 112, 113, 121, 122, 123, 124, 125, 126, 131, 132, 133	All weights	1-, 2-, and 3-axles	0%	10%	10%	10%	2025
	Semi-trailers ^c	421, 422, 423, 431, 432, 433, 611, 612, 621, 622, 623, 624, 625, 631, 632, 633	≥ 8	1-, 2-, and 3-axles	0%	7.5%	7.5%	7.5%	2025
Newly added buses	Urban buses	31-LF, 31-L1, 31-DD, 33-LF, 33-L1, 33-DD, 35-FE, 39-FE	> 3.5	2-, 3-, and 4-axles	0%	90%	100%	100%	2025

^a The reference period for vehicle group 1s is 2025

^b Vehicle groups 111, 112, 121, 122, 123, 124, and 132 also have a second vehicle code, suffixed with a V, to signify if the vehicle is primarily designed for the transport of voluminous goods and has an internal height of more than 2.9 meters

^c Vehicle groups 421, 422, 431, 432, 611, 612, 621, 623, 622, 624, 631, and 632 also have a second vehicle code, suffixed with a V, to signify if the vehicle is primarily designed for the transport of voluminous goods and has an internal height of more than 2.9 meters

COMPLIANCE

Compliance is measured for every manufacturer on a fleet-wide basis, meaning not every vehicle must meet the specified targets, but fleet-averaged emissions must be reduced by these targets. This allows manufacturers to compensate for high-emitting truck with a low-emitting truck, as long as the average emissions are in line with the CO₂ emission reduction targets.

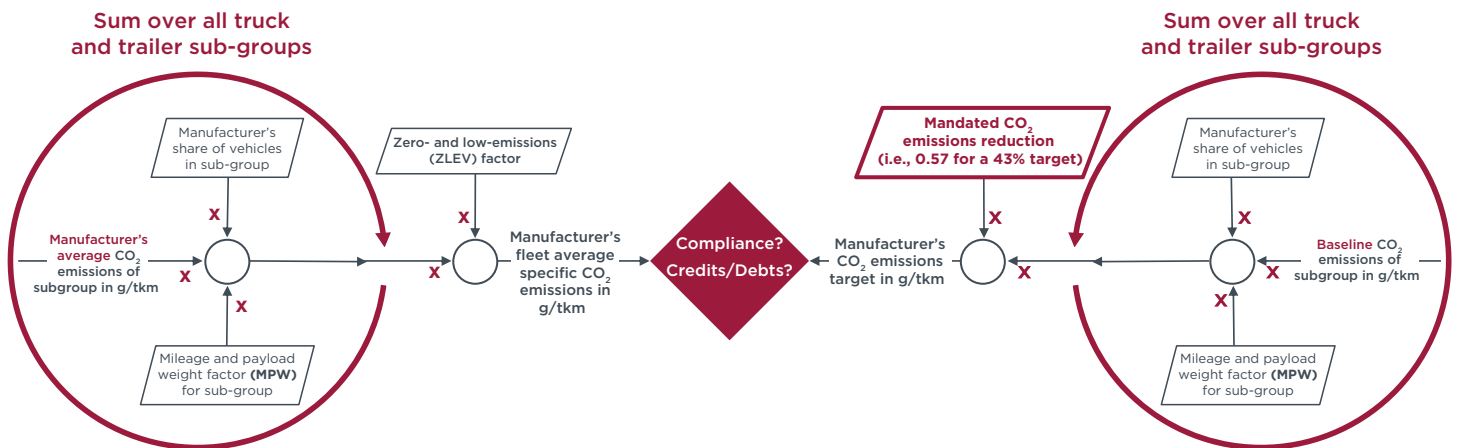
Compliance is measured separately for freight vehicles (trucks and trailers) and passenger vehicles (buses and coaches). This means that a manufacturer will have one overall target for their trucks and trailers in terms of gCO₂/tonne-km (tkm), and a second for their buses and coaches in terms of gCO₂/passenger-km (pkm). The following sections describe the compliance mechanisms for freight and passenger vehicles.

FREIGHT VEHICLES

For freight vehicles, the mechanism under which a manufacturer's target and fleet-average specific CO₂ emissions are calculated remains almost the same as in the original CO₂ standards (see Figure 3). A more detailed description of this process can be found in a previous ICCT publication.²¹ Beyond the extension of the regulations to cover trailers, the only difference introduced to freight vehicle compliance in this revision is the removal of the zero- and low-emission vehicles (ZLEV) factor, a value between 1 and 0.97 depending on the share of zero- and low-emission vehicles a manufacturer produces (the ZLEV factor is discussed in greater detail below). In theory, if a manufacturer produces both trucks and trailers, they could offset their trailer target by overcompliance with trucks and vice-versa. However, there are currently no major manufacturers in Europe that produce both trucks and trailers.

Figure 3

Determination of a manufacturer's average specific CO₂ emissions and CO₂ emissions target for trucks and trailers



Note: The mileage and payload weight (MPW) factor is a value assigned to every vehicle group that weights the group based on its annual mileage and payload (in tonnes for freight vehicles and number of passengers for passenger vehicles); the higher the MPW, the more the vehicle group counts towards a manufacturer's CO₂ emissions target. Baseline emissions refer to the average emissions of a vehicle group recorded across all manufacturers in the baseline year (see Table 1). The ZLEV factor will no longer apply from 2030.

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION [THEICCT.ORG](https://theicct.org)

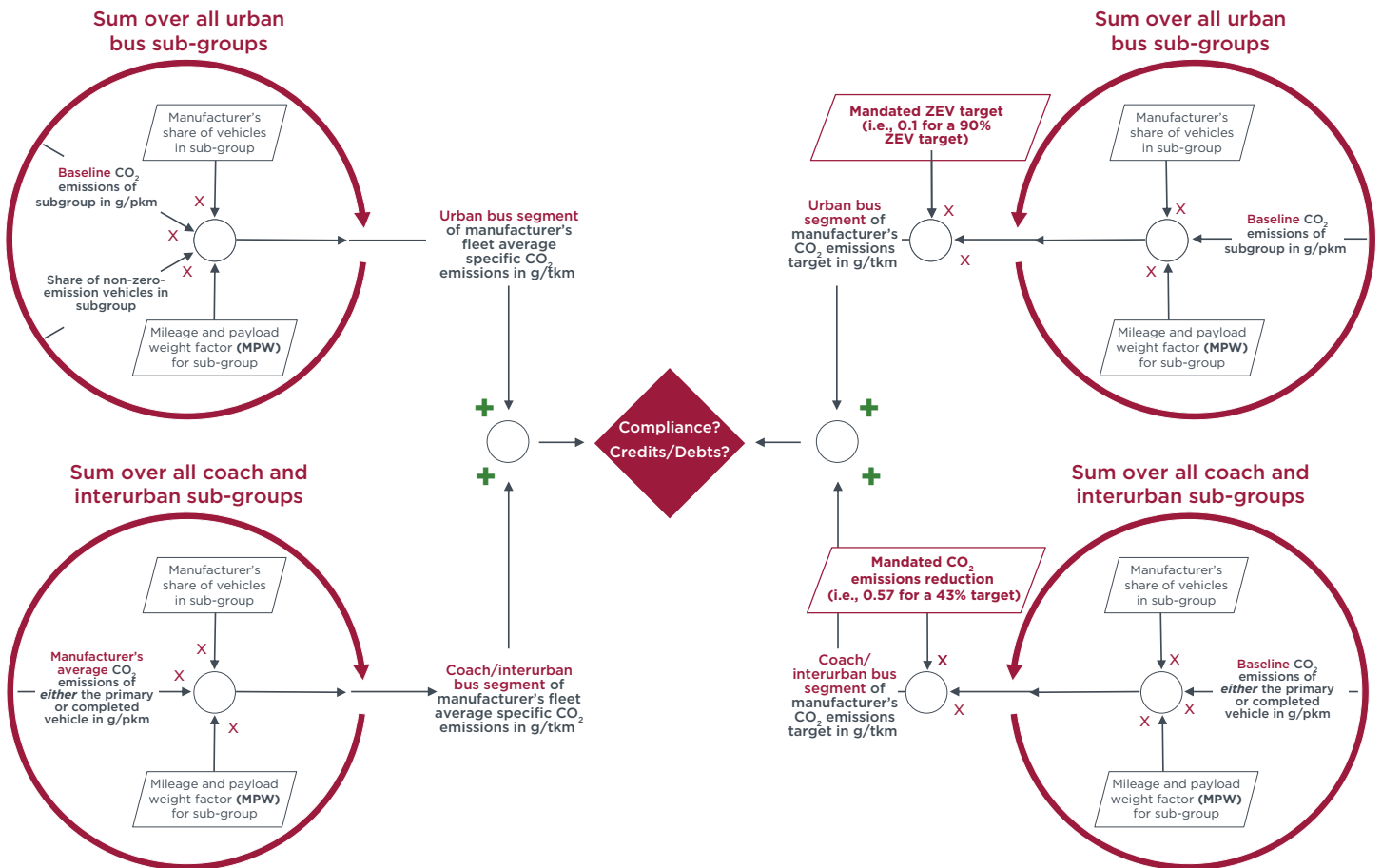
²¹ Felipe Rodríguez, *The European Commission's Proposed CO₂ Standards for Heavy-Duty Vehicles* (Washington, D.C.: ICCT, June 26, 2018), <https://theicct.org/publication/the-european-commissions-proposed-co2-standards-for-heavy-duty-vehicles/>.

PASSENGER VEHICLES

Urban buses are regulated with a zero-emission vehicle share target while coaches and interurban buses are regulated with a CO₂ emissions target. As such, compliance emissions for urban buses are calculated separately from those of coaches and interurban buses; the resulting gCO₂/pkm values are summed together to create one single compliance metric (see Figure 4).

Buses and coaches are often manufactured in a multi-stage process. One manufacturer may produce the chassis of the vehicle (at which point it becomes known as the primary vehicle), while another manufacturer may fit the bodywork to the vehicle (at which point it is known as the completed vehicle). By default, vehicle emissions are calculated based on the completed vehicle. However, a manufacturer may request that primary vehicle emissions be considered if the manufacturer that produced the primary vehicle is a separate and non-connected entity—meaning, broadly, that the two do not share the same parent manufacturer.²² As urban buses have a zero-emission target, only the completed vehicle is considered.

Figure 4
Determination of a manufacturer’s average specific CO₂ emissions and CO₂ emissions target for passenger vehicles



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION THEICT.ORG

²² For the full definition of connected entity, see Article 3 of the revised CO₂ standards.

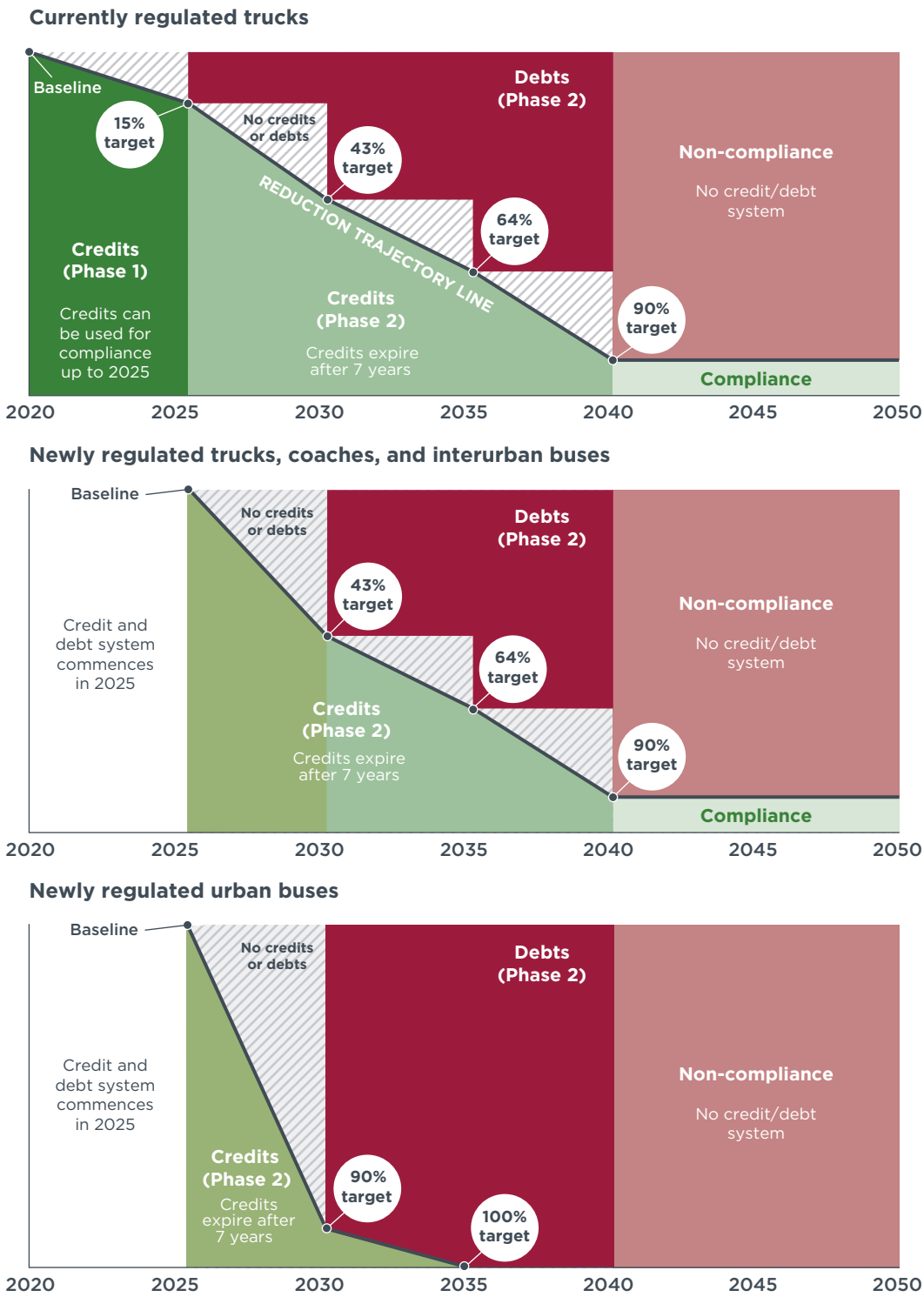
CREDIT AND DEBT SYSTEM

A credit and debt system has been in effect since the inception of the heavy-duty vehicle CO₂ standards. It rewards credits to manufacturers that reduce their emissions below an emissions trajectory line—a straight line connecting two targets (e.g., between 15% in 2025 and 43% in 2030). These credits can then be used to offset debts, which are acquired if a manufacturer has not reduced their emissions below the specific target once the target year is reached. For example, if a manufacturer has not reduced their truck emissions below 43% by 2030, they will earn debts for every year they remain above a 43% reduction. Debts can be earned from 2025 onwards for vehicles regulated under the original CO₂ standards, and from 2030 onwards for vehicles introduced in the revision to the CO₂ standards.

The original credit and debt system had two phases, one which ran from 2019 to 2024, and the second from 2025 to 2029. Credits earned in the first phase can only be used to offset debts accrued in the 2025 reporting year. From 2026 onwards, any credits earned in the first phase are no longer valid.

Under the second phase, debts can be accrued from 2026 and accumulate each year in which a manufacturer remains above their target for 2025. Credits can be used to offset these debts, but these credits have a lifetime of 7 years, after which they expire. Any remaining debts after credits have been used for clearance become known as excess emissions, for which manufacturers must pay a penalty (discussed below). Figure 5 illustrates the new credit and debt system; though trailers can also earn credits and debts following a similar approach, they are not included in the figure. From 2040, the credit and debt system expires, and non-compliance results in immediate penalties.

Figure 5
Revised credit and debt system



Note: Figures represent a system in which manufacturers would earn credits and debts if they only sold the specified vehicles. Most bus manufacturers sell a variety of bus types, meaning credits would be dependent on the sales share of each vehicle.

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION [THEICCT.ORG](https://www.theicct.org)

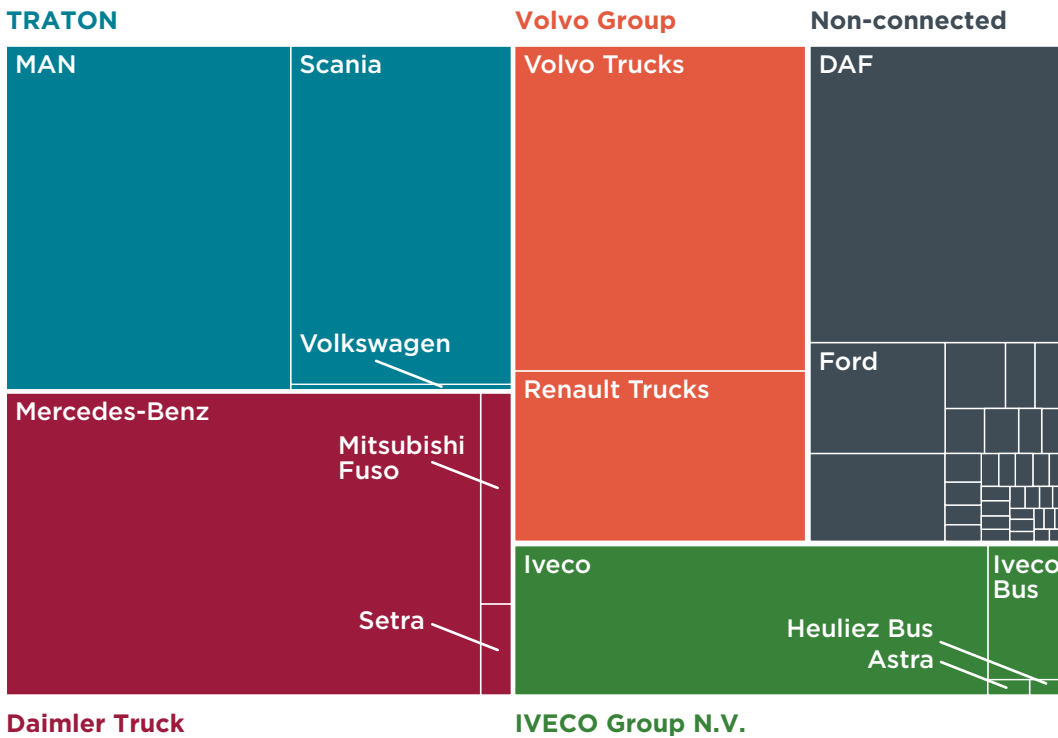
VEHICLE TRADING

Vehicle trading is a new mechanism introduced in this revision of the CO₂ standards. It allows a manufacturer to report another entity's vehicle as their own to comply with their CO₂ target under the proposal. Different rules apply for conventional vehicles and zero-emission vehicles.

For conventional vehicles, manufacturers that share a parent company can transfer an unlimited number of vehicles between themselves.²³ This flexibility allows manufacturers to share the burden of compliance across all entities covered by a parent manufacturer; in theory, a manufacturer could trade all its vehicles to a connected entity, effectively allowing it to pool emissions with another producer. Non-connected manufacturers are unable to trade conventional vehicles. Figure 6 depicts major HDV manufacturers that share a parent company.

For zero-emission vehicles, all manufacturers have the flexibility to trade vehicles, limited to up to 5% of the receiver's sales volume in any given reporting period.

Figure 6
Heavy-duty vehicle manufacturers that share a parent company



Note: Manufacturers of the same color (except grey) have the option to trade both conventional and zero-emission vehicles under the new proposal. The size of the square corresponds to the manufacturer's sales in 2023. Sales shares based on content supplied by S&P Global Mobility; Copyright © S&P Global Mobility, 2023.

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION [THEICCT.ORG](https://www.theicct.org)

DEFINITION OF ZERO-EMISSION VEHICLES

The definition of a zero-emission heavy-duty vehicle has changed in this revision. The original definition allowed for vehicles with emissions of less than 1 gCO₂/kWh to be classified as zero-emission. This threshold has been increased to 3 gCO₂/tkm for trucks and 1 gCO₂/pkm for buses and coaches.

²³ The full definition of a connected entity is provided in Article 3 of the CO₂ standards.

If a vehicle falls below its respective threshold, it can report its emissions as 0 gCO₂/tkm. For context, the most common truck group, 5-LH, had official CO₂ emissions of 56 gCO₂/tkm in 2020.²⁴ There are no official values for buses yet, but the emissions of a standard urban bus are estimated to be 26 gCO₂/pkm.²⁵ The increase in the threshold allows for mono-fuel and dual-fuel hydrogen combustion engines to be classified as zero-emission vehicles. For mono-fuel engines, the combustion of pure hydrogen does not directly produce CO₂, but it does produce nitrogen oxides. These must be handled by an emissions control system that can produce minute emissions of CO₂ as a by-product. Dual-fuel combustion engines operate with a mix of hydrogen and diesel. For example, high-pressure direct injection engines require a diesel fuel pilot injection to initiate the ignition process, which produces CO₂ emissions (but may fall below the 3 gCO₂/tkm threshold).

A trailer is defined as zero-emission if it is equipped either with a non-internal combustion engine device that actively supports its propulsion or an internal combustion engine with emissions below 1 gCO₂/kWh. Unlike trucks and buses, a zero-emission trailer cannot report its emissions as 0 gCO₂/tkm. However, the definition of a zero-emission vehicle for trailers allows them to benefit from the trading mechanism described above. It also allows trailers to benefit from incentives for zero-emission vehicles defined in related legislation, such as the Eurovignette Directive, which establishes the legal basis for road pricing,²⁶ and the Weights and Dimensions Directive, which grants zero-emission vehicles an additional weight allowance above that of conventional vehicles to account for the weight of the alternative powertrain.²⁷

THE ZERO- AND LOW-EMISSION VEHICLE (ZLEV) FACTOR

An incentive mechanism introduced in the original standards, known as the ZLEV factor,²⁸ allows manufacturers to artificially reduce their reported emissions by up to 3% if they produce a sufficient number of ZLEVs. This mechanism is explained in detail in a previous ICCT report.²⁹

The ambition for the sale of zero-emission vehicles of most major manufacturers significantly exceeds the share needed to achieve the maximum benefit from the ZLEV factor. As a result, this incentive will be phased out from 2030 onward. Most major manufacturers have committed to increasing their sales share of ZEVs to 35%-60% by

24 Eamonn Mulholland, Pierre-Louis Ragon, and Felipe Rodríguez, *CO₂ Emissions from Trucks in the European Union: An Analysis of the 2020 Reporting Period* (Washington, D.C.: ICCT, July 11, 2023), <https://theicct.org/publication/hdv-co2-emissions-eu-2020-reporting-jul23/>.

25 Hussein Basma et al., "Comprehensive Energy Assessment of Battery Electric Buses and Diesel Buses," (paper presented at the 32nd International Conference on Efficiency, Cost, Optimization, Simulation, and Environmental Impact of Energy Systems, Wroclaw, Poland, June 2019), <https://hal.science/hal-02169856>. We assume a reference load of 51 people, based on the default values used in VECTO.

26 Directive (EU) 2022/362 of the European Parliament and of the Council of 24 February 2022 Amending Directives 1999/62/EC, 1999/37/EC and (EU) 2019/520, as Regards the Charging of Vehicles for the Use of Certain Infrastructures," OJ L 69/1, March 4, 2022, <https://eur-lex.europa.eu/eli/dir/2022/362/oj>.

27 At the time of writing, the Weights and Dimensions Directive was being revised to further increase the additional weight allowance for zero-emission vehicles; see Proposal for a Directive of the European Parliament and of the Council Amending Council Directive 96/53/EC Laying down for Certain Road Vehicles Circulating within the Community the Maximum Authorised Dimensions in National and International Traffic and the Maximum Authorised Weights in International Traffic, COM/2023/445 final, July 11, 2023, https://transport.ec.europa.eu/document/download/6d96dca5-11f2-4499-81cd-b3d44b67a73d_en?filename=COM_2023_445_0.pdf.

28 A low-emission vehicle is defined as a vehicle with emissions between 0% and 50% of the baseline emissions for each vehicle group.

29 Felipe Rodríguez, *CO₂ Standards for Heavy-Duty Vehicles in the European Union* (Washington, D.C.: ICCT, April 16, 2019), <https://theicct.org/publication/co2-standards-for-heavy-duty-vehicles-in-the-european-union/>.

2030.³⁰ In contrast, the maximum benefit of the ZLEV factor is achieved after 2025 at a zero-emission sales share of 5%.

Between 2025 and 2030, two calculations are applied to freight vehicles to determine a manufacturer's fleet-average emissions, one which applies the ZLEV factor and one which does not. The former is used only in the calculation of debts accrued, while the latter for the calculation of credits. In other words, the ZLEV factor can only help a manufacturer earn credits until 2025 but can help them avoid debts until 2030.

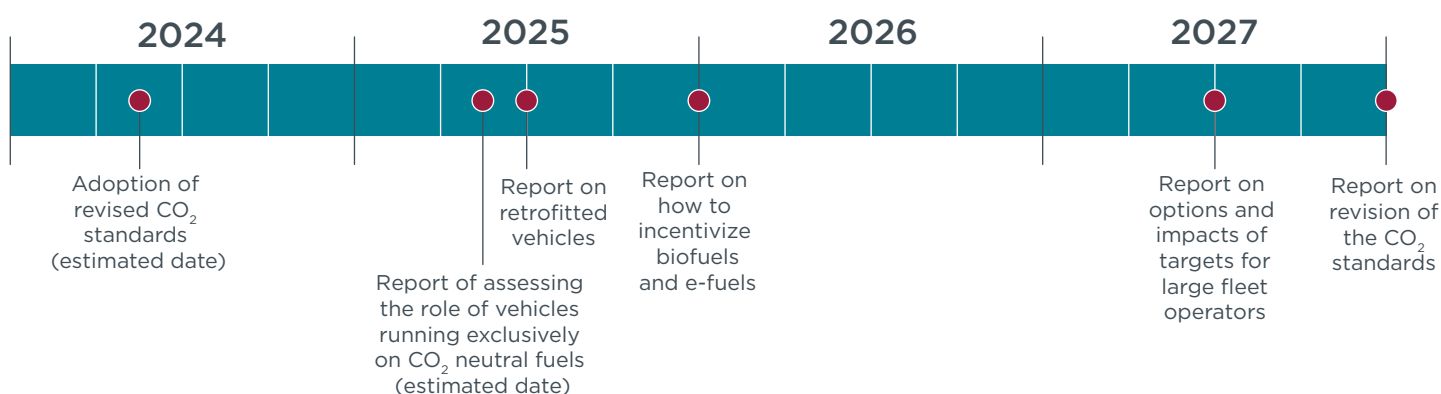
PENALTIES

The penalties for non-compliance have been reduced in the revision of the standards. In the original standards, from 2025, a penalty of €4,250 per vehicle per gCO₂/tkm exceeded was applied, which increased to €6,800 in 2030. In the revision, the latter of these has been removed, with the penalty of €4,250 applying indefinitely from 2025 onward. The penalty faced by manufacturers is based on their vehicle composition, but in general the average truck manufacturer would face a fine of €90 million if it missed its CO₂ target by 1% in any year after 2025.³¹

REVIEW

The revised CO₂ standards require the European Commission to produce five reports over various timelines by the end of 2027 (see Figure 7).

Figure 7
Deadlines for European Commission reports related to the decarbonization of heavy-duty vehicles



Note: The deadline for the report on CO₂ neutral fuels is dependent on the date of adoption of the revised CO₂ standards.

Within one year after the revised CO₂ emission standards have been adopted, the European Commission is required to assess the role of a methodology for registering heavy-duty vehicles running exclusively on CO₂ neutral fuels.

By June 30, 2025, the Commission is required to produce a report considering the need to facilitate the market uptake of heavy-duty vehicles retrofitted into zero-emission vehicles. This report must include an analysis of the options for including such retrofitted vehicles towards these standards and their impacts.

³⁰ Eamonn Mulholland et al., *The HDV CO₂ Standards Europe Needs for Climate Neutrality* (Washington, D.C.: ICCT, March 30, 2022), <https://theicct.org/publication/fs-hdv-co2standards-recs-mar22/>.

³¹ Eamonn Mulholland and Felipe Rodríguez, *An Analysis of the Revision of Europe's Heavy-Duty CO₂ Standards* (Washington, D.C.: ICCT, May 22, 2023), <https://theicct.org/publication/europe-heavy-duty-vehicle-co2-standards-may23/>.

By December 31, 2025, the Commission is required to produce a report analyzing how to incentivize the uptake of advanced biofuels and biogas and renewable fuels of non-biological origin in the heavy-duty vehicles sector.

By June 30, 2027, the Commission must produce a report on options to increase the share of zero-emission heavy-duty vehicles owned or leased by large fleets.

Finally, by the end of 2027, the Commission is required to review the effectiveness of the regulation, notably regarding the objective of climate neutrality by 2050. In this review, the Commission is asked to assess the following:

- » The state of public and private charging infrastructure in the EU-27, and in countries outside the bloc where EU-27 registered trucks frequently operate;
- » Whether the exemption for manufacturers producing less than 100 vehicles per year is justified;
- » The impacts of establishing minimum energy efficiency thresholds for new zero-emission heavy-duty vehicles;
- » The penalties for non-compliance, ensuring they exceed the marginal cost of the technologies required to meet the CO₂ reduction targets;
- » The extension of the scope to cover small trucks with a gross vehicle weight (GVW) ≤ 5 t and special-purpose and off-road vehicles;
- » Options to consider zero-emission vehicles that have been retrofitted from conventional vehicles;³²
- » The role of a carbon correction factor in compliance with the CO₂ targets;
- » The role of allowing vehicles running exclusively on CO₂ neutral fuels to be used by manufacturers in achieving compliance;³³
- » The impacts on employment, the effectiveness of measures to support retraining and upskilling of the workforce, and the importance of an economically viable and socially fair transition towards zero-emission road mobility;
- » Whether the creation of new sub-groups for extra-heavy combination lorries has led to an increase of the engine rated power; and
- » The possibility of developing a common methodology for the assessment of the full lifecycle CO₂ emissions of new heavy-duty vehicles.

³² A separate article (3aa) requires this same assessment to be carried out by June 30, 2025.

³³ A recital (13b) requires this same assessment to be carried out within one year after the entry into force of the regulation.

SUMMARY

The main elements of the original and revised CO₂ standards are highlighted in Table 2.

Table 2
Summary of the revised heavy-duty vehicle CO₂ standards

Metric	Original standards	Revised standards
Scope	4x2 and 6x2 trucks with GVW > 16 t	4x2 and 6x2 trucks with GVW > 16 t 4x2 trucks with GVW 5-16 t 4x2 vans with GVW 5-7.4 t 6x4 and 8x4 trucks Vocational vehicles Buses and coaches Trailers
Targets	Trucks (CO ₂ target): -15% in 2025, -30% in 2030	Trucks, coaches, and interurban buses [CO ₂ target]: -15% in 2025, -43% in 2030, -64% in 2035, -90% in 2040 Trailers [CO ₂ target]: -7.5% in 2030 (drawbar trailers), -10% in 2030 (semi-trailers) Urban buses (ZEV sales share): 90% in 2030, 100% in 2035
Exemptions for SMEs	None	Manufacturers that produce fewer than 100 vehicles in a year are exempt from the standards
Compliance	One compliance metric for all vehicles (gCO ₂ /tonne-km)	Two compliance metrics: One for trucks and trailers (gCO ₂ /tonne-km) and one for buses (gCO ₂ /passenger-km)
Credit and debt system	5-year credit lifetime	7-year credit lifetime
Vehicle trading	None	Connected manufacturers can trade unlimited vehicles; non-connected manufacturers can trade ZEVs up to 5% of the value of all heavy-duty vehicle sales of the receiver
Zero-emission vehicle definition	< 1 gCO ₂ /kWh	< 3 gCO ₂ /tonne-km for trucks < 1 gCO ₂ /passenger-km for buses and coaches < 1 gCO ₂ /kWh for trailers
ZLEV factor	Two phases: super credit phase until 2025 benchmark phase thereafter	Unchanged until 2030, at which point it is phased
Penalty	2025-2030: €4,250 per vehicle per gCO ₂ /tonne-km exceeded 2030 onwards: €6,800 per vehicle per gCO ₂ /tonne-km exceeded	2025 onwards: €4,250 per vehicle per gCO ₂ /tonne-km exceeded
Review	Reviewed in 2023	One year after entry into force: report on including CO ₂ neutral fuels By June 2025: report on facilitating retrofitted vehicles ¹ By December 2025: report on incentivizing CO ₂ neutral fuels By June 2027: report on fleet targets By December 2027: revision of the CO ₂ standards

APPENDIX: VEHICLE GROUPS

Table A1

Vehicle groups of heavy trucks, with a gross vehicle weight (GVW) > 7.4 t, and their characteristics

Vehicle group	Axle configuration	Body type	GVW (t)
1s ^a	4x2	Rigid/Tractor	> 7.4 and ≤ 7.5
1 ^a	4x2	Rigid/Tractor	> 7.5 and ≤ 10
2 ^a	4x2	Rigid/Tractor	> 10 and ≤ 12
3 ^a	4x2	Rigid/Tractor	> 12 and ≤ 16
4 ^a	4x2	Rigid	> 16
5 ^a	4x2	Tractor	> 16
6 ^b	4x4	Rigid	> 7.5 and ≤ 16
7 ^b	4x4	Rigid	> 16
8 ^b	4x4	Tractor	> 16
9 ^a	6x2	Rigid	All weights
10 ^a	6x2	Tractor	All weights
11 ^a	6x4	Rigid	All weights
12 ^a	6x4	Tractor	All weights
13 ^b	6x6	Rigid	All weights
14 ^b	6x6	Tractor	All weights
15 ^b	8x2	Rigid	All weights
16 ^a	8x4	Rigid	All weights
17 ^b	8x6/8	Rigid	All weights
18 ^b	8x2/4/6/8	Tractor	All weights
19 ^b	5 axles, all configurations	Rigid/Tractor	All weights

^a A separate vehicle group exists for each of these groups, suffixed with a 'v,' for vocational vehicles

^b Not covered by the revised CO₂ standards

Table A2**Vehicle sub-groups for heavy trucks and their characteristics**

Vehicle group	Vehicle sub-group	Cab type	Engine power	Operational range
4	4-UD	All	< 170 kW	All
	4-RD	Day cab	≥ 170 kW	All
		Sleeper cab	≥ 170 kW and < 265 kW	
		Sleeper cab	≥ 265 kW	< 350 km
	4-LH	Sleeper cab	≥ 265 kW	≥ 350 km
9	9-RD	Day cab	All	All
		Sleeper cab	All	< 350 km
	9-LH	Sleeper cab	All	≥ 350 km
5	5-RD	Day cab	All	All
		Sleeper cab	< 265 kW	
		Sleeper cab	≥ 265 kW	< 350 km
	5-LH	Sleeper cab	≥ 265 kW	≥ 350 km
10	10-RD	Day cab	All	All
		Sleeper cab	All	< 350 km
	10-LH	Sleeper cab	All	≥ 350 km

Note: A sleeper cab is a type of cab that has a compartment behind the driver's seat intended to be used for sleeping. Day cab refers to all cabs that are not sleeper cabs.

Table A3**Vehicle groups of medium trucks, with 5 t < GVW ≤ 7.4t, and their characteristics**

VECTO group	Axle configuration	Body type	GVW (t)	Driven wheels
51 ^a	4X2	Rigid/Tractor	> 5 and ≤ 7.4	FWD
52 ^a	4X2	Van	> 5 and ≤ 7.4	FWD
53 ^b	4X2	Rigid/Tractor	> 5 and ≤ 7.4	RWD
54	4X2	Van	> 5 and ≤ 7.4	RWD
55 ^a	4X4	Rigid/Tractor	> 5 and ≤ 7.4	AWD
56 ^a	4X4	Van	> 5 and ≤ 7.4	AWD

Note: FWD = front-wheel drive, RWD = rear-wheel drive, AWD = all-wheel drive

^a Not covered by the revised CO₂ standards

^b A separate vehicle group exists for each of these groups, suffixed with a 'v,' for vocational vehicles

Table A4**Vehicle groups of trailers and their characteristics**

Vehicle group	Trailer type	Number of axles	Gross vehicle weight (t)	Bodywork
111	Semi-trailer	1	≥ 8	Soft shell box
112	Semi-trailer	1	≥ 8	Hard shell box
113	Semi-trailer	1	≥ 8	Refrigerated box
121	Semi-trailer	2	≥ 8 and ≤ 18	Soft shell box
122	Semi-trailer	2	> 18	Soft shell box
123	Semi-trailer	2	≥ 8 and ≤ 18	Hard shell box
124	Semi-trailer	2	> 18	Hard shell box
125	Semi-trailer	2	≥ 8 and ≤ 18	Refrigerated box
126	Semi-trailer	2	> 18	Refrigerated box
131	Semi-trailer	3	≥ 8	Soft shell box
132	Semi-trailer	3	≥ 8	Hard shell box
133	Semi-trailer	3	≥ 8	Refrigerated box
421	Draw-bar trailer	2	All weights	Soft shell box
422	Draw-bar trailer	2	All weights	Hard shell box
423	Draw-bar trailer	2	All weights	Refrigerated box
431	Draw-bar trailer	3	All weights	Soft shell box
432	Draw-bar trailer	3	All weights	Hard shell box
433	Draw-bar trailer	3	All weights	Refrigerated box
611	Centre-axle trailer	1	All weights	Soft shell box
612	Centre-axle trailer	1	All weights	Hard shell box
621	Centre-axle trailer	2	≤ 13.5	Soft shell box
622	Centre-axle trailer	2	> 13.5	Soft shell box
623	Centre-axle trailer	2	≤ 13.5	Hard shell box
624	Centre-axle trailer	2	> 13.5	Hard shell box
625	Centre-axle trailer	2	> 13.5	Refrigerated box
631	Centre-axle trailer	3	All weights	Soft shell box
632	Centre-axle trailer	3	All weights	Hard shell box
633	Centre-axle trailer	3	All weights	Refrigerated box

Note: All non-refrigerated box body trailers have a second vehicle code, suffixed with a V, to signify if the vehicle has volume orientation. Volume orientation means that the trailer is primarily designed for the transport of voluminous goods and has an internal height of not less than 2.9 meters.

Table A5

Vehicle groups of buses/coaches and their characteristics

Vehicle group	Vehicle sub-group	Number of Axles	Body type	Floor height	Door	Vehicle Code ^a	Class of vehicle						
							I	I+II or A	II	II + III	III or B		
31a	31-LF	2	Rigid	LF	SD	CE	●	●	●				
31b1	31-L1						●	●					
31b2	31-L2												
31c	31-DD			Open top	SD	CI	CF	●	●	●	●	●	
31d	31-LF							●	●	●	●	●	
31e	31-DD							●	●	●	●	●	
32a	32-C2	2	Rigid	HF	DD	CA			●				
32b	32-C2								●				
32c	32-C3								●				
32d	32-C3				SD				●				
32e	32-DD				DD	CB	●	●	●	●	●		
32f	32-DD						●	●	●	●	●		
33a	33-LF	3	Rigid	LF	SD	CE	●	●	●				
33b1	33-L1						●	●					
33b2	33-L2								●				
33c	33-DD			Open top	DD	CF	CI	CJ	●	●	●	●	
33d	33-LF								●	●	●	●	●
33e	33-DD								●	●	●	●	●
34a	34-C2	3	Rigid	HF	SD	CA			●				
34b	34-C2								●				
34c	34-C3								●				
34d	34-C3				DD	CB			●	●	●		
34e	34-DD						●	●	●	●			
34f	34-DD						●	●	●	●	●		
35a	35-FE	3	Articulated	LF	SD	CG	●	●	●				
35b1	35-FE						●	●					
35b2	35-FE				DD	CH	●	●	●				
35c	35-FE						●	●	●				
36a	34-C2	3	Articulated	HF	SD	CC			●				
36b	34-C2								●				
36c	34-C3								●				
36d	34-C3				DD	CD			●	●	●		
36e	34-DD						●	●	●	●			
36f	34-DD						●	●	●	●			
37a	33-LF	4	Rigid	LF	SD	CE	●	●	●				
37b1	33-L1						●	●					
37b2	33-L2								●				
37c	33-DD			Open top	DD	CF	CI	CJ	●	●	●	●	
37d	33-LF								●	●	●	●	●
37e	33-DD								●	●	●	●	●
38a	34-C2	4	Rigid	HF	SD	CA			●				
38b	34-C2								●				
38c	34-C3								●				
38d	34-C3				DD	CB			●	●	●		
38e	34-DD						●	●	●	●			
38f	34-DD						●	●	●	●			
39a	39-FE	4	Articulated	LF	SD	CG	●	●	●				
39b1	39-FE						●	●					
39b2	39-FE				DD	CH	●	●	●				
39c	39-FE						●	●	●				
40a	34-C2	4	Articulated	HF	SD	CC			●				
40b	34-C2								●				
40c	34-C3								●				
40d	34-C3				DD	CD			●	●	●		
40e	34-DD						●	●	●	●			
40f	34-DD						●	●	●	●			

Notes: HF = high floor, defined as a vehicle with a code CA, CB, CC, or CD

LF = low floor, defined as a vehicle with a code CE, CF, CG, or CH

SD = single deck vehicle

DD = double deck vehicle

^aBody codes are defined in Annex I of (EU) 2018/858 and in UN Regulation No 107

^bVehicle classes are defined in paragraph 2 of UN Regulation No. 107