POLICY UPDATE

MARCH 2025

SUMMARIZES REGULATORY AND OTHER DEVELOPMENTS RELATED TO CLEAN TRANSPORTATION WORLDWIDE

U.S. multi-pollutant emissions standards for model years 2027 and later light-duty and medium-duty vehicles

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On April 18, 2024, the U.S. Environmental Protection Agency (EPA) published a final rule that establishes more stringent standards for greenhouse gas (GHG) and harmful air pollutant emissions from light-duty vehicles (LDVs) and medium-duty vehicles (MDVs) of model years (MYs) 2027 and later.[1] It establishes distinct standards for LDVs and MDVs that require tailpipe carbon dioxide (CO_2) emission reductions (in grams per mile, g/mi) that lower the industry-wide average for LDVs by 50% and for MDVs by 44%, both compared with the MY 2026 standards. Additionally, the rule establishes a new Tier 4 criteria pollutant emissions standard for non-methane organic gases (NMOG), nitrogen oxides (NO_x), particulate matter (PM), and other criteria pollutants and their precursors. Consistent with EPA's historical approach, the new standards are performance-based; manufacturers are free to select from an array of clean vehicle technologies and compliance does not require selling any particular technology.

Light-duty vehicles are a significant source of GHG emissions in the United States. They contribute 57% of transportation emissions and 16% of GHG emissions in the United States, before considering emissions from MDVs.[2] According to EPA, the new standards will reduce approximately 7.2 billion metric tons of carbon dioxide equivalent (CO_2e) emissions from 2027 through 2055, and approximately 8,700 U.S. tons of $PM_{2.5}$, 36,000 U.S. tons of NO_x, and 150,000 U.S. tons of volatile organic compounds annually by 2055. These reductions are projected by EPA to lead to up to $13 billion in annualized health benefits attributed to $PM_{2.5}$ and $72 billion in annualized climate benefits by

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1 Multi-pollutant Emissions Standards for Model Years 2027 and Later Light-duty and Medium-duty Vehicles, 89 F.R. 27842 (April 18, 2024) (codified at 40 C.F.R. § 85, 86, 600, 1036, 1037, 1066, and 1068), https://www.govinfo.gov/content/pkg/FR-2024-04-18/pdf/2024-06214.pdf; hereby referred to throughout as the multi-pollutant rule.

2 Office of Transportation and Air Quality, *Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions 1990-2022* (U.S. Environmental Protection Agency, 2024), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P101AKR0.pdf.

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2055. The new multi-pollutant rule builds on the standards for GHG emissions for LDVs finalized in December 2021 for MY 2023 to MY 2026 vehicles and reflects foundational investments from the Infrastructure Investment and Jobs Act and the Inflation Reduction Act of 2022 that helped to accelerate the development and deployment of clean vehicle technologies.[3]

GREENHOUSE GAS EMISSIONS STANDARDS

LIGHT-DUTY VEHICLES

Light-duty vehicles, as defined by the National Highway Traffic Safety Administration, include passenger cars and light trucks.[4] The LDV GHG emissions standards are split into two categories—in-use standards that apply to individual vehicle models, and fleet-average standards determined by the makeup of a manufacturer's fleet.

In-use standards are based on the model's combined city and highway tailpipe emissions value calculated for each carline/subconfiguration (i.e., design). To determine compliance, vehicles undergo a U.S. federal test procedure that uses a dynamometer to simulate real-world driving conditions; it is weighted at 55% city driving and 45% highway driving. Battery electric vehicles (BEVs) are assigned a compliance value of zero for having no tailpipe emissions. For plug-in hybrid electric vehicles (PHEVs), the compliance value is scaled based the EPA-estimated utility factor, which is the percentage of miles traveled using electricity. Prior research showed that EPA's utility factor overestimated the share of electric driving when compared with real-world data.[5] The multi-pollutant rule reduces the estimated utility factor for PHEVs beginning in MY 2031.

Fleet-average standards are based on vehicle footprints, defined as a vehicle's wheelbase multiplied by the average track width (i.e., the area enclosed by the points where the wheels meet the ground). Although a manufacturer's fleet-average standard in any given MY can be estimated based on projected production volumes, manufacturers must comply with the fleet-average standard based on their final MY production volumes and fleet composition. The fleet-average standard is determined by the production-weighted average emissions of each vehicle in the fleet.

To determine the footprint-based standards for LDVs, EPA defines curves for passenger cars and light trucks separately. These curves establish the relationship between vehicle footprint and target emission levels. Table 1 and Table 2 show the coefficients for the parameters that define these curves for passenger cars and light trucks, respectively. Based on these values, manufacturers can calculate the target GHG emission levels for any model in their fleet, from MY 2027 to MY 2032, as follows: *Slope* × *Footprint* + *Intercept*. Vehicles with footprints falling below the minimum or

3 Revised 2023 and Later Model Year Light-duty Vehicle Greenhouse Gas Emissions Standards, 86 F.R. 74434 (December 30, 2021) (codified at 40 C.F.R. § 86 and 600), https://www.govinfo.gov/content/pkg/FR-2021-12-30/pdf/2021-27854.pdf; Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, 135 Stat. 429 (2021), https://www.govinfo.gov/content/pkg/PLAW-117publ58/pdf/PLAW-117publ58.pdf; Inflation Reduction Act of 2022, Pub. L. No. 117-169, 136 Stat. 1818 (2022) August 16, 2022. https://www.congress.gov/bill/117th-congress/house-bill/5376/text/rh.

4 Corporate Average Fuel Economy Standards for Passenger Cars and Light Trucks for Model Years 2027 and Beyond and Fuel Efficiency Standards for Heavy Duty Pickup Trucks and Vans for Model Years 2030 and Beyond, 89 F.R. 52945 (August 23, 2024) (codified at 49 C.F.R. § 523, 531, 533, 535, 536, and 537). https://www.federalregister.gov/documents/2024/06/24/2024-12864/corporate-average-fuel-economy-standards-for-passenger-cars-and-light-trucks-for-model-years-2027.

5 Aaron Isenstadt et al., *Real World Usage of Plug-in Hybrid Vehicles in the United States* (International Council on Clean Transportation, 2022), https://theicct.org/publication/real-world-phev-us-dec22/.

above the maximum footprint limits would have target emission levels based on the minimum and maximum CO_2 targets, respectively. No individual vehicle is required to have a GHG emissions level in alignment with its calculated target. Instead, compliance is based on the production-weighted average emissions of all passenger cars or light trucks in a manufacturers' fleet in each MY.

Table 1
Footprint-based standard curve coefficients for passenger cars

Parameter	2027	2028	2029	2030	2031	2032
Min CO_2 (g/mi)	135.9	123.8	110.6	98.2	85.3	71.8
Max CO_2 (g/mi)	145.2	131.6	117.0	103.4	89.8	75.6
Slope (g/mi/ft²)	0.66	0.60	0.54	0.47	0.41	0.35
Intercept (g/mi)	108.0	97.9	87.0	76.9	66.8	56.2
Min footprint (ft²)	42	43	44	45	45	45
Max footprint (ft²)	56	56	56	56	56	56

Table 2
Footprint-based standard curve coefficients for light trucks

Parameter	2027	2028	2029	2030	2031	2032
Min CO_2 (g/mi)	150.3	136.8	122.7	108.8	91.8	75.7
Max CO_2 (g/mi)	239.9	211.7	184.0	158.3	133.5	110.1
Slope (g/mi/ft²)	2.89	2.58	2.27	1.98	1.67	1.38
Intercept (g/mi)	28.9	25.8	22.7	19.8	16.7	13.8
Min footprint (ft²)	42	43	44	45	45	45
Max footprint (ft²)	73	72	71	70	70	70

The coefficients shown in Table 1 and Table 2 result in the standards curves for passenger cars and light trucks as depicted in Figure 1 and Figure 2. The dashed gray lines show the MY 2026 standards for comparison.

Figure 1

Footprint-based standards curves for passenger cars model years 2026 through 2032

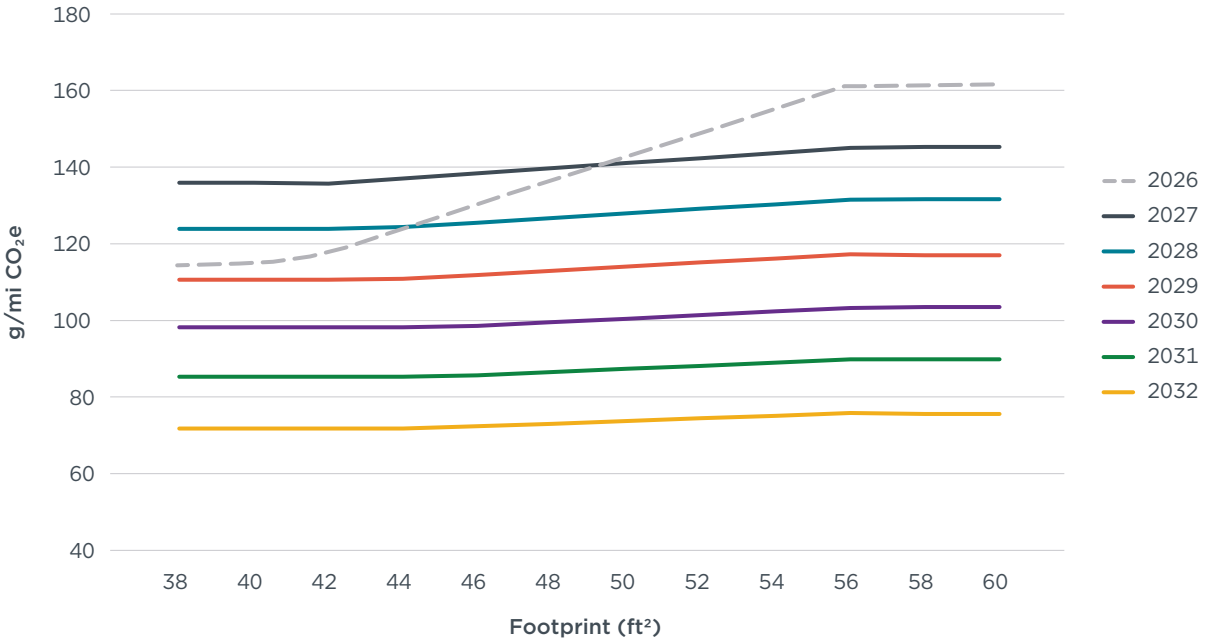

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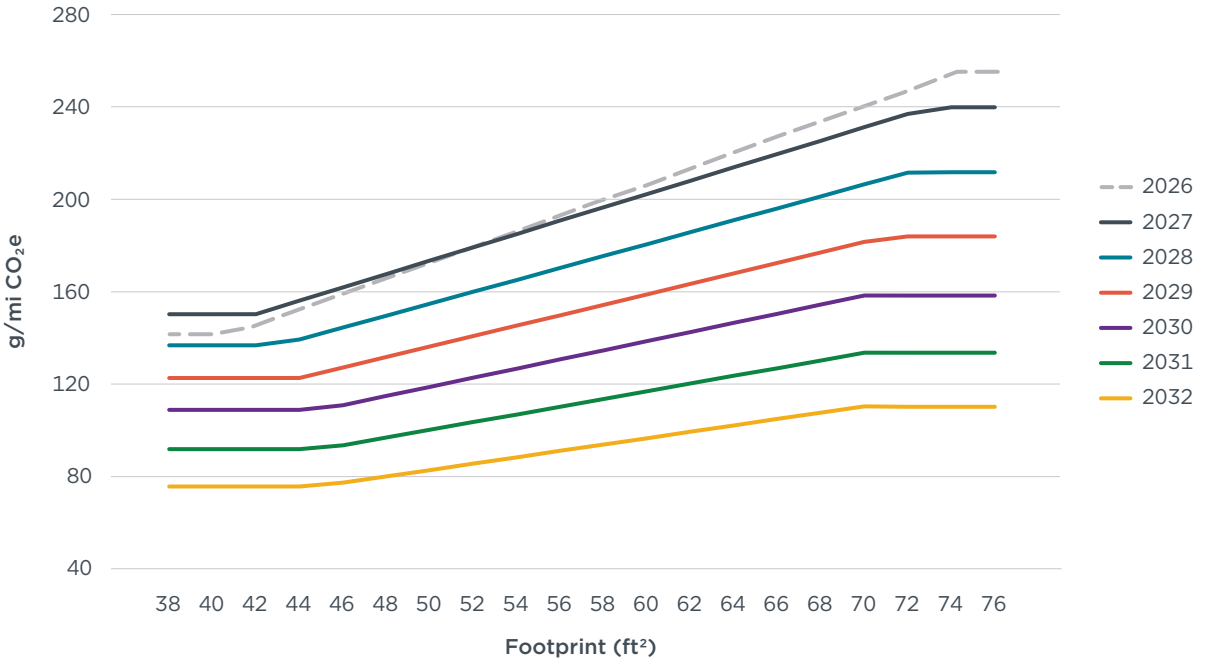
Figure 2

Footprint-based standards curves for light trucks for model years 2026 through 2032



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These curves are significantly less steep in the multi-pollutant rule than in the MY 2026 standards, and they become progressively flatter each year of the rule. This flattening

of the standards curves reflects EPA's goal of disincentivizing manufacturers from complying by upsizing their fleets to meet less-stringent standards. The footprint of vehicles, and thus size and weight, have gradually increased over time, and this has partially offset emissions improvements from standards; it led to nearly plateauing GHG emissions levels between MY 2015 and MY 2024 when excluding electric vehicles from the calculation.[6] In addition to disincentivizing upsizing, the flatter curves reflect the improvement and increased proliferation of advanced emission control technologies throughout the automotive industry, including the increased adoption of zero-emission vehicles, for which there is no relationship between increased vehicle footprint and increased tailpipe emissions. Improvements in the effectiveness of advanced emission control technologies also lessen the relationship between increased vehicle footprint and increased tailpipe emissions for conventional internal combustion engine (ICE) vehicles, hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs).

As with previous standards, the curves also shift down each year under the multi-pollutant rule to ensure that vehicles with the same footprint demonstrate consistent improvement over time. The cutpoints, the high and low footprint boundaries beyond which the standards curves are flat, were updated by increasing the lower cutpoint by 1 ft^2 per year for passenger cars from 41 ft^2 to 45 ft^2 and decreasing the upper cutpoint by 1 ft^2 per year for light trucks from 74 ft^2 to 70 ft^2 between MY 2027 and MY 2030. This means slightly less stringent standards apply for the smallest cars to incentivize the continued sale of the smallest vehicles, which are among the cleanest. It also ensures that emission reductions of trucks are not lost in future years due to upsizing.

Compliance with these standards is projected to bring significant reductions in GHG emissions from LDVs. Compared with the current standards covering MYs 2023–2026, which reduce annual light-duty GHG emissions by an average of 6% per year, the multi-pollutant rule is expected to reduce light-duty GHG emissions by nearly 11% per year on average between MY 2026 and MY 2032. Table 3 shows the projected emission targets between MY 2027 and MY 2032 for passenger cars, light trucks, and the total LDV fleet, with the MY 2026 standards included for reference.

Table 3

Projected light-duty industry-wide CO_2 emissions targets

Model year	Cars CO_2 (g/mi)	Trucks CO_2 (g/mi)	Total fleet CO_2 (g/mi)
2026	131	184	168
2027	139	184	170
2028	125	165	153
2029	112	146	136
2030	99	128	119
2031	86	109	102
2032 and later	73	90	85

6 U.S. Environmental Protection Agency, *The 2024 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology Since 1975* (2024), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P101CUU6.pdf.

While the combined LDV fleet target in MY 2032 is 85 g/mi CO_2, based on a fleet mix that is 30% cars and 70% trucks, the definitive target may differ depending on the final mix of cars and trucks sold. This target represents a 49% reduction from the projected emissions target under the existing MY 2026 standards. For passenger cars, the target in MY 2032 is 73 g/mi of CO_2, a 44% reduction from the target in MY 2026. For light trucks the target in MY 2032 is 90 g/mi of CO_2, a 51% reduction from the target in MY 2026.

Flexibilities for compliance

Averaging, banking, and trading

As with previous standards, the multi-pollutant rule provides flexibility for manufacturers to comply through the averaging, banking, and trading (ABT) of credits. Through the ABT program, manufacturers that demonstrate tailpipe emissions improvements exceeding what the standards require generate credits that can be used to offset excess emissions (i.e., averaged) when manufacturers are not able to fully comply with the standards in another year. These credits can be used by the manufacturer that generated the credits or sold (i.e., traded) to other manufacturers that need them to comply with the standards. Credits that a manufacturer generates in a given MY can be held (i.e., banked) and used to comply with standards in a future year or retroactively used to comply with standards not met in a previous MY. The multi-pollutant rule maintains a 5-year carry-forward and a 3-year carry-back limit for banked ABT credits.

Off-cycle, air conditioning leakage, and air conditioning efficiency credits

Manufacturers generate air conditioning (A/C) and off-cycle credits by demonstrating emissions improvements from A/C units (i.e., improved A/C efficiency and reduced A/C leakage) and off-cycle technologies (e.g., active aerodynamic improvements, high efficiency exterior lights), respectively. These A/C and off-cycle credits are distinct from the credits used in ABT and are added to the fleet-average emissions to reach or exceed compliance with the standards. If a manufacturer exceeds the standards, then they generate ABT credits that can be used as described above.

The multi-pollutant rule changes the available A/C and off-cycle credits for LDVs by eliminating off-cycle and A/C efficiency credits for light-duty BEVs starting in MY 2027, phasing down A/C leakage credits by MY 2031, and phasing out off-cycle credits by MY 2033. Historically, A/C and off-cycle credits were not sufficiently validated with data to show that real-world emissions benefits are equivalent to the value of the credits.[7] By limiting the available A/C and off-cycle credits and phasing them out over time, manufacturers must demonstrate real-world emissions improvements by deploying more effective advanced emission control technologies.

Table 4 shows the adjusted light-duty emission targets when factoring out the maximum A/C and off-cycle credits available to manufacturers. In addition to improving the real-world emissions of LDVs, the changes to the A/C and off-cycle credits address the discrepancy between the MY 2026 standards and the multi-pollutant rule where GHG emissions limits become less stringent between MY 2026 and MY 2027 (as shown in Table 3).

7 Nic Lutsey and Peter Slowik, *How Will Off-Cycle Credits Impact U.S. 2025 Efficiency Standards?* (International Council on Clean Transportation, 2018), https://theicct.org/publication/how-will-off-cycle-credits-impact-u-s-2025-efficiency-standards/.

Table 4

Credit-adjusted projected light-duty industry-wide CO_2 emissions targets

Model year	Cars CO_2 (g/mi)	Trucks CO_2 (g/mi)	Total fleet CO_2 (g/mi)
2026	161	220	201
2027	158	209	193
2028	142	186	172
2029	125	163	151
2030	108	141	131
2031	93	118	111
2032 and later	78	98	92

MEDIUM-DUTY VEHICLES

In the MDV category are Class 2b and 3 vehicles, defined under the Heavy-duty Phase 2 GHG program as having a gross vehicle weight rating (GVWR) between 8,501 and 14,000 lb. These include large pickups and vans with greater towing and hauling capacities than LDVs. The GHG emissions of MDVs were previously governed by the Heavy-duty Phase 2 GHG program, and the multi-pollutant rule revises the MY 2027 standards and provides new GHG standards for MDVs from MY 2027 through MY 2032.

The GHG standards for MDVs are not based on vehicle footprints, like the LDV standards, but rather on a work factor (WF) metric that accounts for the work potential of these vehicles by factoring in payload, towing, and 4-wheel drive equipment. The equations that define the WF and the corresponding CO_2 target are identical to the ones used for Class 2B and 3 vehicles under the Heavy-duty Phase 2 GHG program, but the coefficients are changed in the multi-pollutant rule. The equation for the CO_2 target (Equation 1) is as follows:

$$CO_2\ Target\ (g/mi) = [a \times WF] + b, \text{ where the}$$
$$WF = [0.75 \times (Payload\ Capacity + xwd)] + [0.25 \times Towing\ Capacity]$$

Equation 1

Where:

payload capacity = the GVWR less the vehicle's curb weight, in lb;

xwd = either 500 lb for a vehicle with 4-wheel-drive capability or 0 lb for a vehicle with 2-wheel drive capability; and

towing capacity = the gross combined weight ratio (GCWR) less the GVWR, in lb.

Table 5 shows the coefficients for the CO_2 target equation.

Table 5

Coefficients for medium-duty vehicle greenhouse gas standards

Model year	a	b
2027	0.0348	268
2028[a]	0.0339	270
2029[b]	0.0310	246
2030[c]	0.0280	220
2031[c]	0.0251	195
2032[c]	0.0221	170

[a] Only applicable at WF < 8,000 lb
[b] Only applicable at WF < 6,800 lb
[c] Only applicable at WF < 5,500 lb

In line with public comments from industry, EPA did not adopt a GCWR limit of 22,000 lb for the WF calculation, but is flattening the WF-based standards for MDVs to avoid potential windfall compliance credits for vehicles with GCWR's greater than 22,000 lb. The flattened curves are phased in between MY 2028 and MY 2032 to allow for gradual increases in the stringency of the GHG emissions standards. Table 6 shows the MDV GHG limits and corresponding WF cutpoints where the limits apply.

Table 6

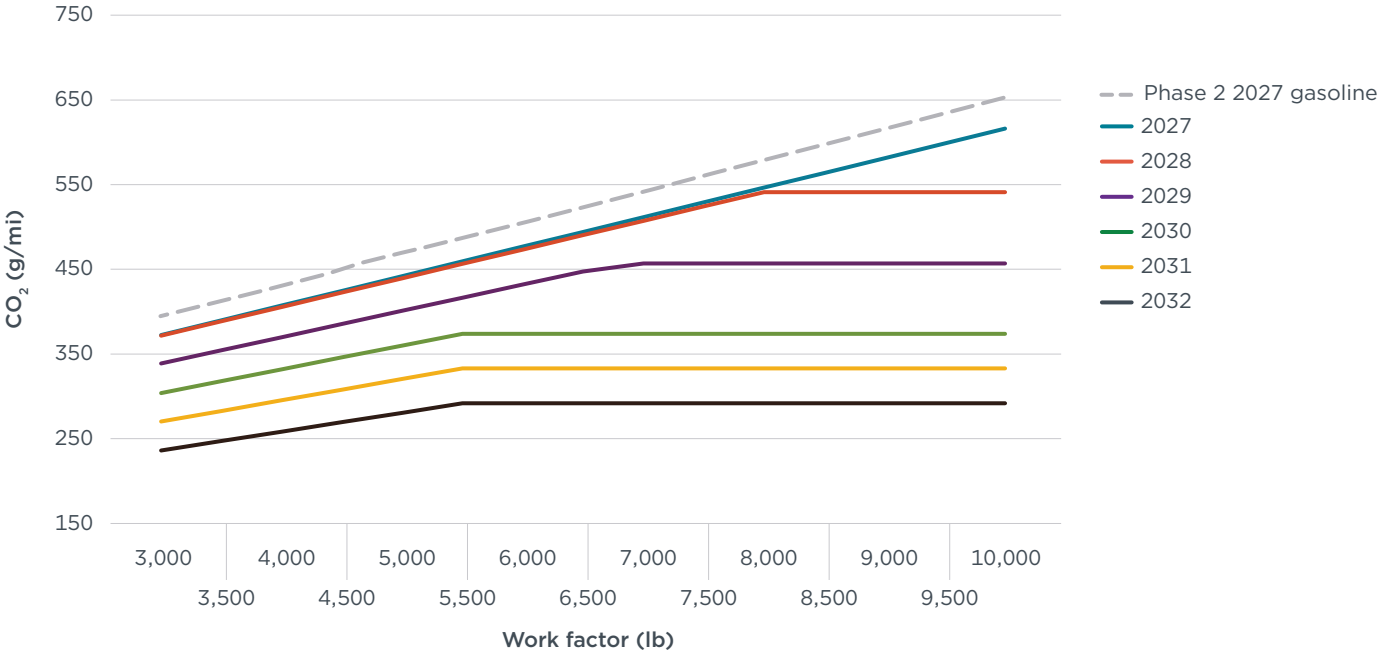
Work factor cutpoints and emission limits for medium-duty vehicle greenhouse gas standards

Model year	Work factor cutpoint (lb)	Greenhouse gas emissions limit (g CO_2/mi)
2028	8,000	541
2029	6,800	457
2030	5,500	374
2031	5,500	333
2032	5,500	292

Figure 3 depicts the standards curves for MY 2027 through 2032 based on the coefficients in Table 5 and the cutpoint limits in Table 6; it also shows the MY 2027 gasoline standards from the Heavy-duty Phase 2 rule for reference.

Figure 3

Work-factor-based standards curves for medium-duty vehicles for model years 2027 through 2032



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As with the LDV standards, the MDV GHG standards are performance-based and manufacturers may comply using any mix of technologies. This is a change from the Heavy-duty Phase 2 rule, which had separate standards for gasoline and diesel MDVs and did not project significant adoption of vehicle electrification. The MY 2027 curve is identical to the curve for diesel MDVs from the Phase 2 GHG program and the gasoline curve no longer applies, as EPA determined that development of advanced emission control technologies have narrowed the differences in GHG emissions between gasoline and diesel medium-duty ICE vehicles.

Manufacturers are also provided flexibility to comply with the MDV GHG standards with an ABT program for credits generated from exceeding the standards each year; these credits have the same 5-year carry-forward and 3-year carry-back limits as the ABT credits for LDVs. While MDVs also can generate off-cycle credits, they do not generate A/C credits. Instead, MDV fleets must meet a A/C refrigerant leakage standard of no more than 11 g per year or a leakage rate no greater than 1.5% per year, and they are not subject to any kind of A/C efficiency provisions in the GHG standards.

Table 7 shows the projected GHG emission targets for MDVs across the industry. The total combined MDV fleet target in MY 2032 is 274 g/mi of CO_2, a 41% reduction from the MY 2027 target. The MY 2032 target for vans is 245 g/mi of CO_2, a 38% reduction from the MY 2027 target, and the MY 2032 target for pickups of 290 g/mi of CO_2 is a 42% reduction from the MY 2027 target.

Table 7

Projected medium-duty industry-wide CO_2 emissions targets

Model year	Vans CO_2 (g/mi)	Pickups CO_2 (g/mi)	Total fleet CO_2 (g/mi)
2027	392	497	461
2028	391	486	453
2029	355	437	408
2030	317	371	353
2031	281	331	314
2032 and later	245	290	274

CRITERIA POLLUTANT EMISSIONS STANDARDS

The multi-pollutant rule establishes new standards to limit the criteria pollutant emissions from LDVs, medium-duty passenger vehicles (MDPVs), and MDVs. Currently, EPA defines an MDPV as a heavy-duty vehicle (i.e., a vehicle with a curb weight above 6,000 lb or a frontal area greater than 45 ft^2) with a GVWR less than 10,000 lb that is 1) not an incomplete vehicle, 2) has seating for more than 12 passengers, 3) has seating for more than 9 passengers behind the driver's seat, or 4) has an open cargo area longer than six feet. In the multi-pollutant rule, EPA expanded the definition of MDPVs to include the following: pickups with a GVWR at or below 14,000 lb, a WF at or below 4,500 lb, and an interior cargo area shorter than 8 ft; pickups with a GVWR less than 9,500 lb and an interior cargo area shorter than 8 ft, regardless of its WF; and pickups with a GVWR between 9,500 and 14,000 lb, a WF above 4,500 lb, and an interior cargo area shorter than 6 ft. These definitions account for pickups that might be traditionally categorized as LDVs but are heavier due to partial electrification and thus could be slightly modified to qualify as MDVs to be subject to less-stringent emissions standards. The same emissions standards apply to MDPVs and LDVs for both for GHG and criteria pollutant emissions.

There are several revisions in the new criteria pollutant standards (the Tier 4 standards), including new testing procedures requiring that the standards are met across four test cycles—25 °C FTP, HFET, US06, and SC03. Additionally, EPA is harmonizing the -7 °C FTP nonmethane hydrocarbons standards for LDVs and MDPVs, which were previously separate, by creating a singular fleet average standard of 300 mg/mi. The multi-pollutant rule also finalizes standards for PM of 0.5 mg/mi.

In the Tier 4 standards for NMOG+NO_x bin structure, -7°C NMOG+NO_x, PM, carbon monoxide, formaldehyde, -7°C carbon monoxide, and the three NMOG+NO_x provisions that are aligned with the California Air Resources Board's Advanced Clean Cars II regulation (i.e., PHEV high-power cold starts, early driveaway, and intermediate soak mid-temperature starts) phase-in over time.[8] Table 8 shows the phase-in schedule for the Tier 4 standards for LDVs, MDPVs, and MDVs.

8 Exhaust Emission Standards and Test Procedures—2026 and Subsequent Model Year Passenger Cars, Light-duty Trucks, and Medium-duty Vehicles, 13 CA ADC § 1961.4 (2022), https://govt.westlaw.com/calregs/Document/I42B3EB107B9E11EDA8A9DEC7E923577F?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1.

Table 8

New sales phase-in schedules for criteria pollutant emissions standards

Model years	Light-duty vehicles and light-duty trucks 1-2 (GVWR <= 6000 lb)	Light-duty trucks 3-4 (GVWR 6,001–8,500 lb) and medium-duty passenger vehicles (GVWR 8,501–14,000 lb)		Medium-duty vehicles (GVWR 8,501–14,000 lb)	
		Default	Early option	Default	Early option
2027	20%	0	20%	0	20%
2028	40%	0	40%	0	40%
2029	60%	0	60%	0	60%
2030	100%	100%	100%	0	80%
2031				100%	100%

The phase-in schedule applies to the shares of new vehicle sales that must meet the standards in a given MY. Manufacturers can designate vehicles that are not to be included in the phase-in schedule—considered Tier 4 interim vehicles—but they must still meet all Tier 3 standards established in 2014.[9] For LDVs and light-duty trucks (LDTs) with a GVWR less than or equal to 6,000 lb (i.e., LDV and LDT1-2), the schedule increases the share of Tier 4 vehicles from 20% of new sales in MY 2027 to 100% in MY 2030. Manufacturers can choose either a default option or an early option phase-in schedule for LDTs with a GVWR between 6,000 and 8,500 lb (i.e., LDT3-4) and for MDPVs. The default option provides 3 years of lead time and then requires 100% of MY 2030 vehicles to be compliant with Tier 4 standards; the early option gradually increases the required percentage of compliant vehicles from 20% in MY 2027 to 100% in MY 2030. If manufacturers choose the early phase-in schedule, they can average the Tier 4 emissions of their LDV, LDT1-2, LDT3-4, and MDPV fleets. Similarly, MDVs can follow either a default or early option phase-in schedule. If a manufacturer selects an early phase-in schedule for MDVs, they may carry forward Tier 3 NMOG+NO_x credits that are otherwise lost.

In addition to meeting the phase-in schedule, manufacturers must also meet NMOG+NO_x fleet-average standards. Table 9 shows the Tier 4 fleet-average NMOG+NO_x standards for LDVs (and MDPVs) and MDVs. The MY 2026 standards are shown from the Tier 3 rule for reference. For LDVs, the Tier 4 standards are projected to reduce NMOG+NO_x average emissions by 50%, from 30 mg/mi to 15 mg/mi, by MY 2032 compared with MY 2026. For MDVs, the Tier 4 standards are projected to reduce NMOG+NO_x average emissions by 58% for Class 2b vehicles and by 70% for Class 3 vehicles when compared with the Tier 3 MY 2026 standards, reaching 75 mg/mi by MY 2033.

9 Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards, 89 F.R. 23414 (April 28, 2014) (codified at 40 C.F.R. § 79, 80, 85, 86, 600, 1036, 1037, 1039, 1042, 1048, 1054, 1065, and 1066). https://www.govinfo.gov/content/pkg/FR-2014-04-28/pdf/2014-06954.pdf.

Table 9

NMOG+NO_x emissions standards for light- and medium-duty vehicles

Model year	Light-duty vehicles NMOG+NO_x (mg/mi)	Medium-duty vehicles NMOG+NO_x (mg/mi)	
		Class 2b	Class 3
2026	30	178	247
2027	25	175	
2028	23	160	
2029	21	140	
2030	19	120	
2031	17	100	
2032	15	80	
2033 and later	15	75	

The standards shown for LDVs in Table 9 are the default compliance option of LDVs and LDT1-2 vehicles; LDT3-4 vehicles and MDPVs can follow these standards as an early compliance option. Alternatively, their default compliance option would be to follow the Tier 3 MY 2026 standards through MY 2029 and then shift to the Tier 4 MY 2032 standards in MY 2030. Because the Clean Air Act requires 4 years of lead time and 3 years of consistent standards when regulating heavy-duty vehicles for specific criteria pollutants, MDVs, which were previously classified as heavy-duty vehicles, can follow the standards shown for MDVs as an early compliance option. Alternatively, their default compliance option would be to follow the applicable Tier 3 MY 2026 standards through MY 2030 and then shift to the MY 2033 Tier 4 standards in MY 2031.

PROJECTED MIX OF TECHNOLOGIES

As the standards are performance-based, EPA provides projections of the expected technology penetration rates based on its analysis of technology costs and the most cost-effective mix of technologies to comply. Table 10 shows these projections for LDVs under Pathway A, EPA's "central analysis" case. The agency performed sensitivity analyses to assess other cases, as well—Pathways B and C; across the different cases, electric vehicle penetration rates are approximately the same, ranging from 68% to 73% in 2032, but the mix of PHEVs and BEVs varies significantly. In Pathways B and C, ICE vehicle penetration rates are eight to 12 percentage points lower than in the central case due lower penetration of BEVs.

Table 10

Light-duty fleet projected technology penetration rates under the final GHG standards for various scenarios

Pathway	Model Year	Internal combustion engine vehicles	Hybrid electric vehicles	Battery electric vehicles	Plug-in hybrid electric vehicles
Pathway A – Higher BEV Pathway ("central analysis" case)	2027	64%	4%	26%	6%
	2028	58%	5%	31%	6%
	2029	49%	5%	39%	8%
	2030	43%	4%	44%	9%
	2031	35%	3%	51%	11%
	2032	29%	3%	56%	13%
Pathway B – Moderate HEV and PHEV Pathway	2027	62%	4%	24%	10%
	2028	56%	4%	29%	12%
	2029	49%	3%	33%	15%
	2030	39%	6%	37%	18%
	2031	28%	7%	41%	24%
	2032	21%	6%	43%	29%
Pathway C – Higher HEV and PHEV Pathway	2027	61%	4%	24%	10%
	2028	41%	15%	26%	17%
	2029	35%	13%	30%	22%
	2030	27%	16%	31%	27%
	2031	19%	15%	34%	32%
	2032	17%	13%	35%	36%
No Action Case	2027	65%	4%	26%	5%
	2028	63%	3%	27%	6%
	2029	59%	3%	30%	7%
	2030	57%	3%	31%	8%
	2031	52%	5%	34%	8%
	2032	48%	5%	35%	12%

U.S. Environmental Protection Agency projects that manufacturers will sell greater numbers of electric vehicles to comply with the standards: BEVs and PHEVs together are projected to grow from 32% in MY 2027 to 68% in MY 2032. The projection of increased electric vehicle adoption, especially of BEVs, does not indicate any preference for a specific technology, but rather is based on EPA's assessment of the most cost-effective way for manufacturers to comply with the standards. This determination generally aligns with the ICCT's estimated timeline for upfront cost parity between BEVs and ICE vehicles.[10] In a no-action scenario without the rule, EPA

10 Peter Slowik et al., *Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame* (International Council on Clean Transportation, 2022), https://theicct.org/publication/ev-cost-benefits-2035-oct22/.

expects that electric vehicles would still represent 31% of the market in MY 2027 and 47% in MY 2032. As such, EPA anticipates that most of the increased electric vehicle adoption will be due to the impacts of the Inflation Reduction Act, more consumer acceptance, and automaker investments.

Table 11 shows EPA's projected technology penetration rates for MDVs. Like LDVs, manufacturers are expected to sell a significant number of medium-duty BEVs to comply. Electric vehicles are projected to increase from 3% in MY 2027 to 43% in MY 2032. Unlike LDVs, the multi-pollutant rule is expected to be a significant catalyst for the adoption of medium-duty BEVs; under a no-action scenario, the estimated penetration rates of electric vehicles are 3% in MY 2027 and only 8% by MY 2032.

Table 11

Medium-duty fleet projected technology penetration rates under the multi-pollutant rule

Model years	Internal combustion engine vehicles	Battery electric vehicles	Plug-in hybrid electric vehicles
2027	97%	3%	0%
2028	96%	4%	0%
2029	86%	14%	0%
2030	73%	22%	5%
2031	62%	29%	3%
2032	57%	32%	11%

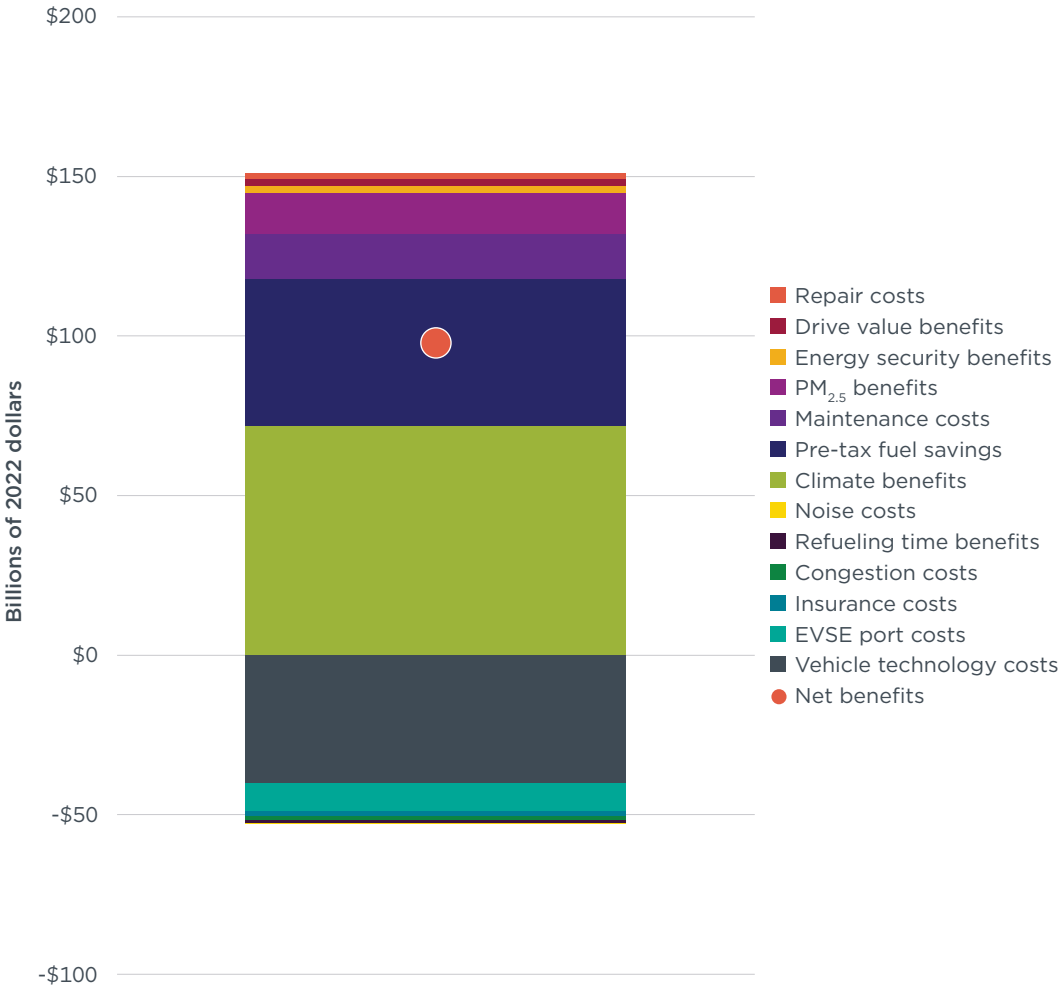
PROJECTED BENEFITS

According to EPA estimates, the multi-pollutant rule will avoid 7.2 billion metric tons of cumulative CO_2e emissions from LDVs and MDVs between 2027 and 2055 compared with a no-action scenario with the MY 2026 standards in place indefinitely. Additionally, EPA projects that the rule will avoid 8,700 U.S. tons of $PM_{2.5}$, 36,000 U.S. tons of NO_x, and 150,000 U.S. tons of NMOG, per year by 2055. The reductions in GHG and criteria pollutant emissions from the multi-pollutant rule will help to mitigate the effects of climate change and lead to significant health benefits and avoided premature deaths for Americans.

Figure 4 illustrates the monetized, annualized benefits and costs of the multi-pollutant rule, including emissions benefits, non-emissions benefits, fuel savings, charging infrastructure costs, and other costs of the program. Per EPA estimates, the benefits of the program far outweigh the costs, with approximately $99 billion in net annualized benefits, at a discount rate of 2%, between 2027 and 2055.

Figure 4

Annualized costs, benefits, and fuel savings of the multi-pollutant rule, 2027 through 2055



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Annualized emissions benefits are estimated by EPA to be about $85 billion, which include $72 billion in climate benefits from GHG emission reductions and $13 billion in health benefits from reducing criteria pollutants of $PM_{2.5}$ that are associated with premature death and hospitalization from respiratory and cardiovascular illness, heart attacks, asthma, and reduced lung functionality. Annualized vehicle technology costs to comply with the program are estimated at $40 billion, and annualized savings on maintenance and repair costs are estimated at $16 billion. With more efficient vehicles, consumers will be able to drive more for the same cost; the increased driving, known as the rebound effect, is anticipated to lead to an estimated $1.2 billion in annualized noise and congestion costs. Significant fuel savings are expected and estimated at an annualized value of $46 billion; this will be partly offset by costs in new electric vehicle supply equipment, which are estimated at an annualized amount of $9 billion.

JOBS IMPACT

As with previous standards, the multi-pollutant rule projects increased diversification and deployment of clean vehicle technologies that will affect domestic manufacturing and employment associated with these technologies. The increased electrification of the LDV and MDV fleets expected under the multi-pollutant rule, shown in Table 10 and Table 11, could be particularly impactful as already seen by market developments ahead of the rule's implementation. As of March 2024, prior to the multi-pollutant rule, manufacturers had made investments worth nearly $200 billion in electric vehicle and battery manufacturing and created nearly 200,000 EV-related jobs.[11]

Table 12 shows EPA's estimated range of partial employment effects (i.e., net jobs impact) from the multi-pollutant rule. These effects reflect changes to new LDV sales (i.e., demand effect) and changes to vehicle technology costs (i.e., cost effect) during the time frame of the rule, and the associated combined jobs impact to sectors focused on the ICE portion of vehicle production, the electrified portion of vehicle production, and to sectors common to both. Because there is limited available data on the labor intensity of ICE vehicles versus BEVs and PHEVs, EPA did not account for the employment effects that changing labor intensities would cause, and therefore these results only reflect partial employment effects. According to EPA projections, there will be a potential net jobs gain in each year under the multi-pollutant rule ranging from 1,600 new jobs in 2027 to nearly 190,000 new jobs in 2032.

Table 12

Estimated jobs created from the multi-pollutant rule when accounting for changing vehicle technology costs and changing light-duty vehicle sales

Year	Lower bound (number of jobs)	Upper bound (number of jobs)
2027	1,600	9,400
2028	6,000	34,900
2029	14,000	80,200
2030	17,600	124,700
2031	20,800	161,700
2032	17,400	188,100

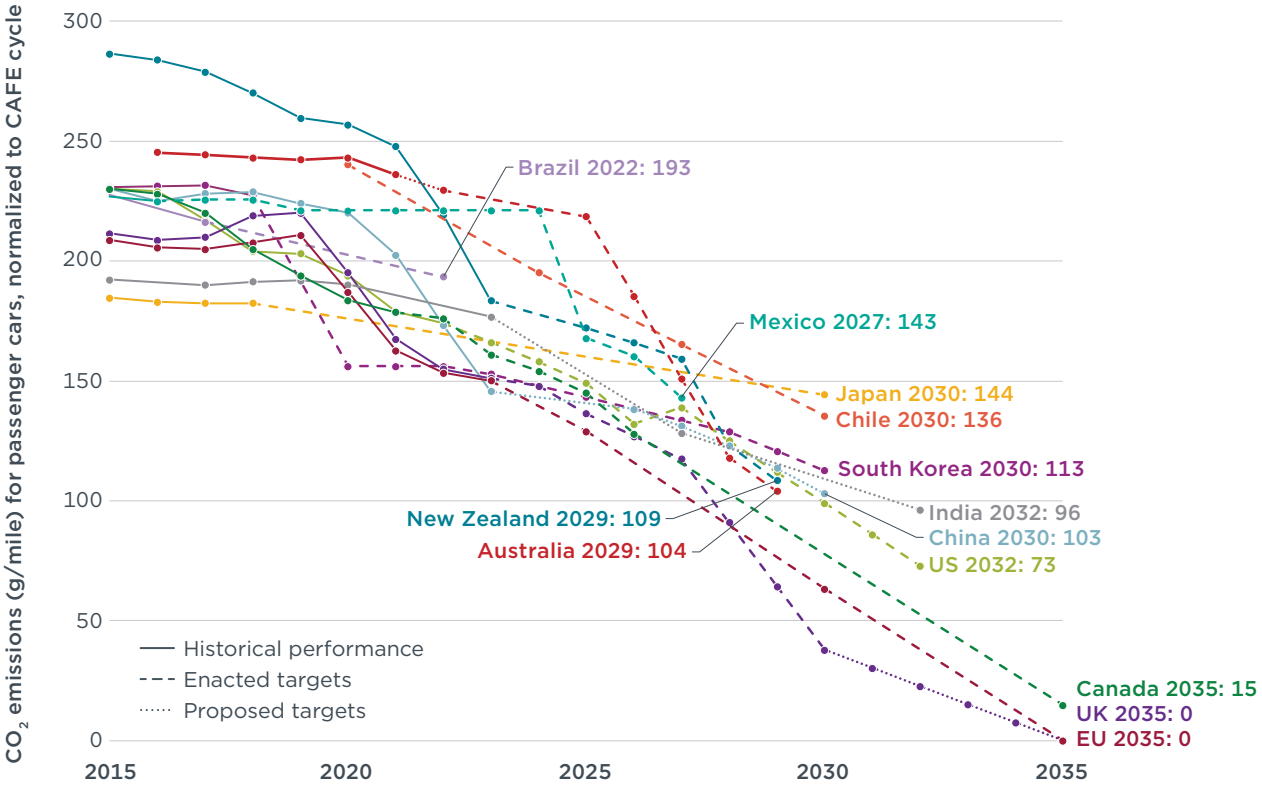
11 Environmental Defense Fund, "U.S. Electric Vehicle Investments Have Grown to $188 Billion, Almost 200,000 Jobs – New Report," press release, March 12, 2024, https://www.edf.org/media/us-electric-vehicle-investments-have-grown-188-billion-almost-200000-jobs-new-report.

INTERNATIONAL CONTEXT

The multi-pollutant rule puts the United States on track to catch up with regions like the European Union and China, which have been among the global leaders in efforts to decarbonize transportation. Figure 5 and Figure 6 show the enacted and proposed emission targets from around the world for light-duty passenger cars and LDTs, respectively. The projected emissions targets from the multi-pollutant standards are shown in lime green.

Figure 5

Light-duty passenger cars emission targets from enacted and proposed regulations around the world



Note: UK fleet-average targets are estimated based on non-ZEV CO_2 emissions and ZEV mandates. Canada 2035 target is estimated based on Canada's 2035 ZEV mandate.

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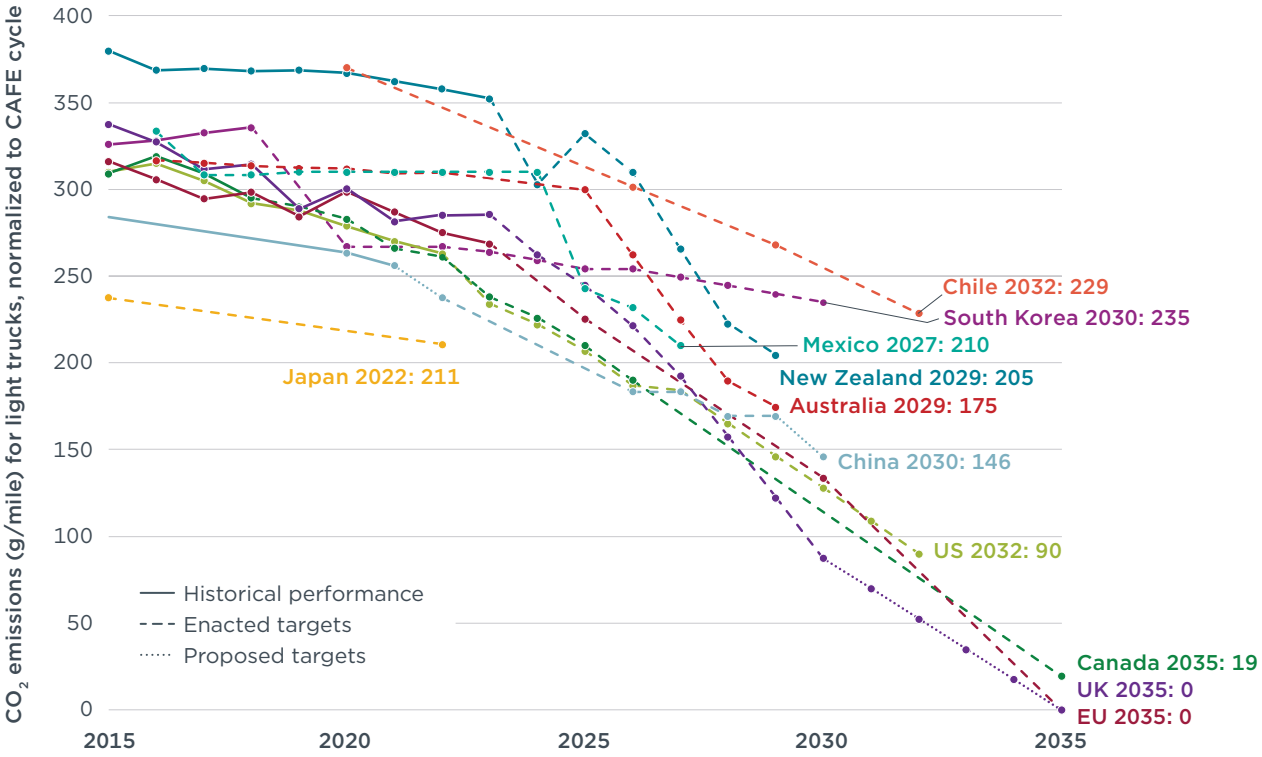
Figure 6

Light-duty trucks emission targets from enacted and proposed regulations around the world



Note: UK fleet-average targets are estimated based on non-ZEV CO_2 emissions and ZEV mandates. Canada 2035 target is estimated based on Canada's 2035 ZEV mandate.

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With the multi-pollutant rule, emissions from U.S. passenger cars and light trucks would be the fourth lowest of any region by 2032, behind the European Union, the United Kingdom, and Canada, the former two of which are both projected to reach zero emissions by 2035. Canada adopted an Electric Vehicle Availability Standard requiring increasing ZEV sales on an annual basis up to 100% ZEV sales by 2035, but interim GHG targets are not yet defined.[12]

12 "Canada's Zero-Emission Vehicle Sales Targets," Transport Canada, last modified October 28, 2024, https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/canada-s-zero-emission-vehicle-sales-targets.

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