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# $CO_2$ emission standards to achieve Mexico's 2030 electrification target for light-duty vehicles

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## INTRODUCTION

Mexico is one of the leading light-duty vehicle (LDV) markets and in terms of domestic sales, ranked 12th globally with 1.4 million vehicles sold in 2023.[1] Mexico's on-road vehicles are responsible for more than 90% of the carbon dioxide ($CO_2$) emissions from the transport sector and nearly one-fourth of the country's total $CO_2$ emissions.[2] To reduce emissions from LDVs, which are an estimated 65% of on-road transport $CO_2$ emissions, Mexico introduced $CO_2$ emission standards for new LDVs in 2013.[3] The standards set annual g $CO_2$/km targets through 2016 and were later extended through 2018.[4]

In late 2022, when Mexico submitted its updated Nationally Determined Contribution as part of its obligation under the Paris Agreement, it committed to reducing greenhouse gas (GHG) emissions by 35% economywide and by 22% from transport sector, in 2030, compared with the business as usual levels.[5] At the same time, Mexico announced a target

1 Instituto Nacional de Estadística, Geografía e Informática, "Registro Administrativo de la Industria Automotriz de Vehículos Ligeros" [Administrative Registry of the Light Vehicle Automotive Industry], accessed January 12, 2024, https://www.inegi.org.mx/datosprimarios/iavl/#Datos_abiertos.

2 "Mexico," Climate Action Tracker, last modified December 12, 2022, https://climateactiontracker.org/countries/mexico/policies-action/; "Mexico," International Energy Agency, accessed on August 8, 2024, https://www.iea.org/countries/mexico/emissions.

3 This estimate of LDV share of transport emissions was obtained from the ICCT's Roadmap model version 2.5, (2024), https://theicct.github.io/roadmap-doc/versions/v2.5/.

4 NORMA Oficial Mexicana NOM-163-SEMARNAT-ENER-SCFI-2013, Emisiones de bióxido de carbono ($CO_2$) provenientes del escape y su equivalencia en términos de rendimiento de combustible, aplicable a vehículos automotores nuevos de peso bruto vehicular de hasta 3 857 kilogramos [Official Mexican Standard NOM-163-SEMARNAT-SCFI-ENER-2013, Carbon dioxide ($CO_2$) emissions from the exhaust and their equivalence in terms of fuel efficiency, applicable to new motor vehicles with a gross vehicle weight of up to 3,857 kilograms], DOF: 21/06/2013, https://dof.gob.mx/nota_detalle.php?codigo=5303391&fecha=21/06/2013#gsc.tab=0

5 Secretaría de Medio Ambiente y Recursos Naturales, *Actualización de la Contribución Determinada a Nivel Nacional NDC de México 2022* [Mexico's 2022 Nationally Determined Contribution 2022 Update]. (2024), https://www.gob.mx/cms/uploads/attachment/file/937518/06_2024.ACTUALIZACI_N_DE_LA_CONTRIBUCI_N_DETERMINADA_A_NIVEL_NACIONAL_190624_Rev2.pdf. Nationally Determined Contributions are plans and commitments that countries submit to the United Nations Framework Convention on Climate Change every 5 years as part of the 2015 Paris Agreement.

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of 50% of new LDV sales being zero-emission by 2030.[6] Although this is a significant increase from the 1.3% electric vehicle (EV) sales share for LDVs in 2023, it is not unrealistic compared with the ambitious zero-emission vehicle (ZEV) sales targets and requirements in other major vehicle markets, including Canada, Europe, the United Kingdom, and the United States.[7] Mexico is also a signatory to the global ZEV Declaration, and along with other developing economies has committed to achieving 100% ZEV sales globally by 2040.[8]

The second phase of Mexico's national $CO_2$ standards was adopted in January 2024, following a regulatory gap from 2019.[9] This brief evaluates the $CO_2$ emissions impact of the Phase 2 standards and finds that, due to numerous compliance flexibilities, they will not put Mexico on track to meet its electrification and climate targets. We additionally model the impacts of alternative policy scenarios that could help achieve Mexico's electrification target by 2030.

## REGULATORY CONTEXT

Mexico's Secretariat of Environment and Natural Resources (SEMARNAT) released the Phase 2 federal $CO_2$ emission standards, NOM-163-SEMARNAT-SCFI-2023 (NOM 163), in January 2024 and they apply to LDVs with gross vehicle weight up to 3,857 kg.[10] The standards establish mandatory annual $CO_2$ limits for new LDVs for model years 2025–2027 and set voluntary, retrospective flat limits for model years 2019–2024.

NOM 163 regulates tailpipe $CO_2$ emissions and sets annual g $CO_2$/km limits for manufacturers. Each manufacturer must meet a sales-weighted average limit derived based on the $CO_2$ performance and footprint of vehicles sold in a given year.

The first phase of NOM 163 regulated LDV fuel economy (km/L) and g $CO_2$/km emissions for 2012 to 2016; this emulated the U.S. Corporate Average Fuel Economy (CAFE) standard and the U.S. Environmental Protection Agency's first LDV $CO_2$ standards.[11] With Phase 1 of NOM 163 in place, a fleet average of 150 g $CO_2$/km was expected by the end of 2016.

In 2016, the governments of Canada, Mexico, and the United States committed to align their fuel efficiency or GHG standards for LDVs by 2025.[12] As Mexico's post-2016 standards were not published immediately, the target for 2016 was held flat and

6 "Mexico, Governments in Emerging Markets and Developing Economies," Accelerating to Zero Coalition, accessed September 18, 2024, https://acceleratingtozero.org/signatories/mexico/.

7 The EV sales share includes both battery electric and plug-in hybrid electric vehicles; the latter are not zero-emission vehicles as they have a combustion engine and produce tailpipe emissions when they burn fuel in the engine. The White House, "Fact Sheet: President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks," August 5, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/; International Council on Clean Transportation, "Passenger Vehicle Greenhouse Gas Emissions and Fuel Consumption," updated April 2024, https://theicct.org/pv-fuel-economy/.

8 "Zero Emission Vehicles Declaration," Accelerating to Zero Coalition, https://acceleratingtozero.org/the-declaration/. The Declaration clarifies "a zero-emission car and van is one that produces zero greenhouse gas emissions at the tailpipe."

9 NORMA Oficial Mexicana NOM-163-SEMARNAT-SCFI-2023, "Emisiones de bióxido de carbono ($CO_2$) provenientes del escape, aplicable a vehículos automotores nuevos de peso bruto vehicular de hasta 3 857 kilogramos", [Official Mexican Standard NOM-163-SEMARNAT-SCFI-2023, DOF: 03/01/2024, https://dof.gob.mx/nota_detalle.php?codigo=5713555&fecha=03/01/2024#gsc.tab=0

10 NORMA Oficial Mexicana NOM-163-SEMARNAT-SCFI-2023.

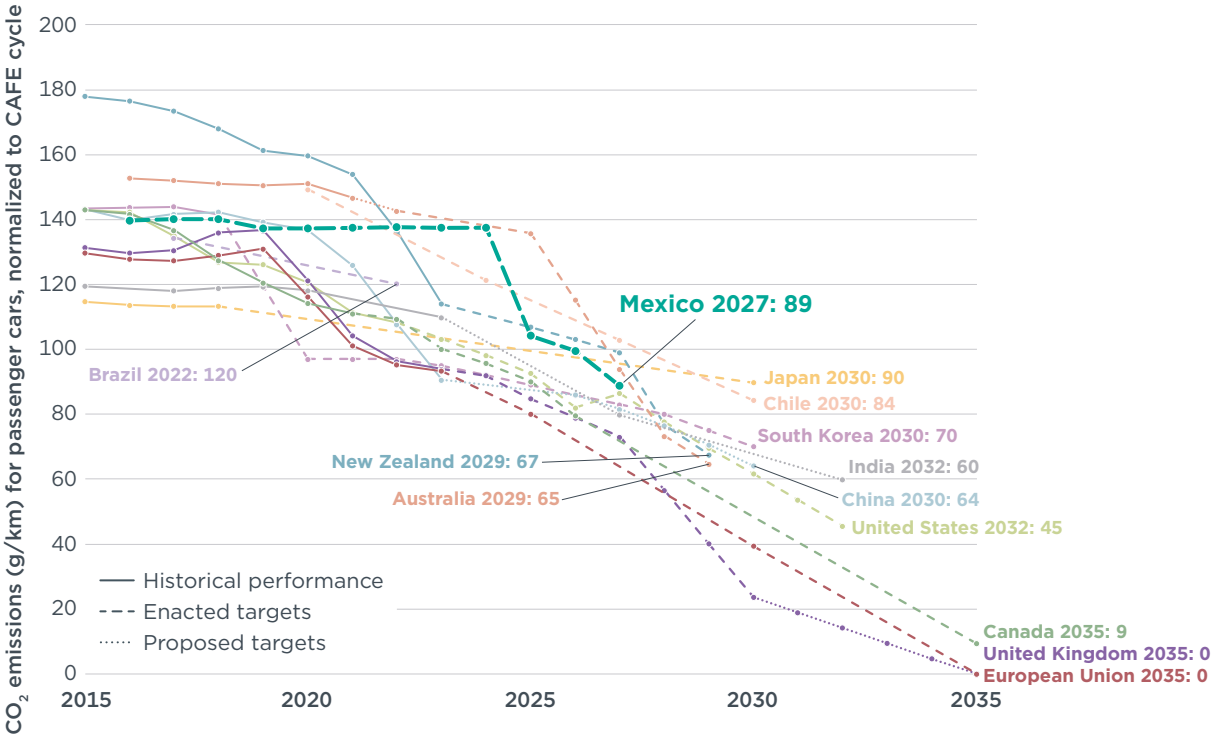
11 NORMA Oficial Mexicana NOM-163-SEMARNAT-ENER-SCFI-2013.

12 The White House, "Leaders' Statement on a North American Climate, Clean Energy and Environment Partnership," press release, June 29, 2016, https://obamawhitehouse.archives.gov/the-press-office/2016/06/29/leaders-statement-north-american-climate-clean-energy-and-environment.

extended through model year 2018. In September 2018, SEMARNAT published a proposal to update the standards for model years 2019–2025. The regulatory process was paused, however, and it was not until 2023 that Phase 2 discussions resumed. The modified standard subsequently published in January 2024 regulates only $CO_2$ emissions. The annual targets are set to achieve 89 g $CO_2$/km for passenger cars (PCs) and 131 g $CO_2$/km for light commercial vehicles (LCVs) by 2027.[13]

Figures 1 and 2 compare Mexico's emission trajectories for PCs and LCVs, respectively, with those in other major markets. All emission values are normalized to the U.S. CAFE cycle using the ICCT's cycle conversion factors and converted to g $CO_2$/km.[14] Note that Mexico's emissions targets are generally less stringent than those in most other markets. Although the 2027 target for PCs roughly aligns with the g $CO_2$/km-equivalent target in the United States—it is only 3% higher—Mexico's targets are less stringent in practice due to the generous compliance flexibilities and credits offered to manufacturers that are not found in the U.S. rule.

**Figure 1**
**Passenger car $CO_2$ emissions**



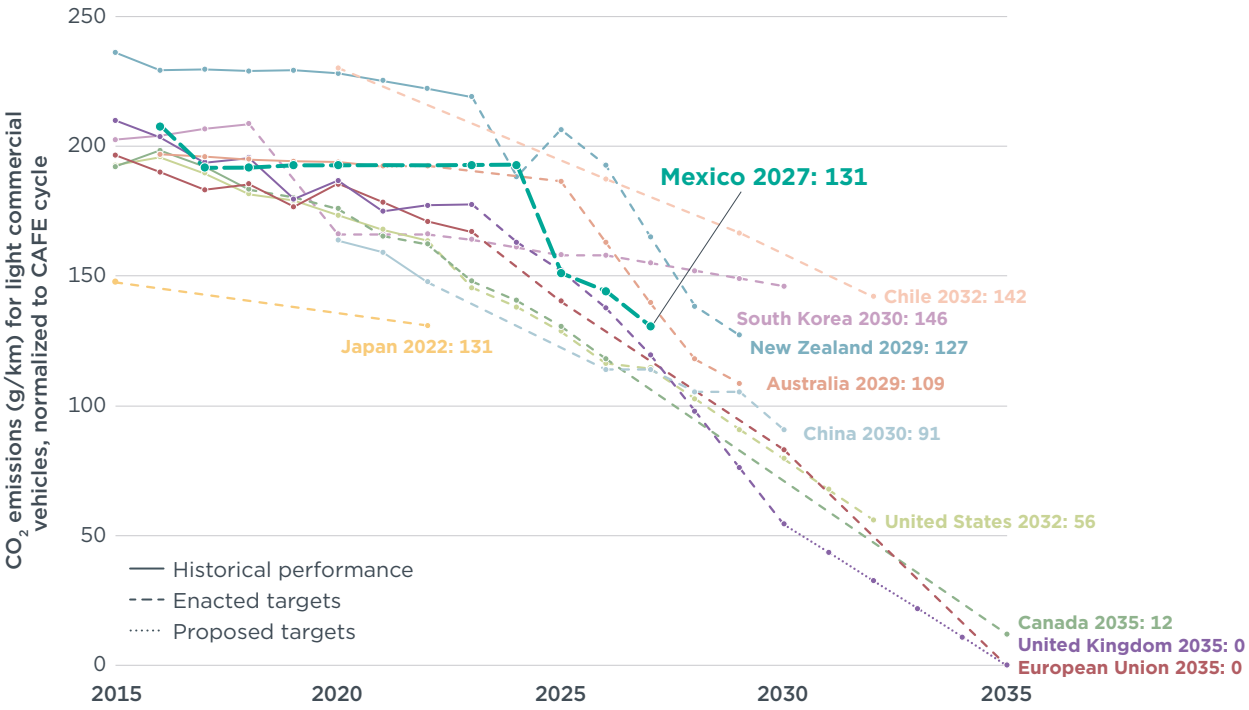

*Notes:* UK fleet-average targets estimated based on non-ZEV $CO_2$ emissions and ZEV mandate.
Canada 2035 target is estimated based on Canada's 2035 ZEV mandate.
The U.S. 2027 target and beyond reflect the changes in the credits flexibilities including off-cycle and A/C credits.



13 Limits values defined under the U.S. Corporate Average Fuel Economy (CAFE) cycle. CAFE fuel economy testing is done over the Federal Test Procedure 75 (FTP-75) weighted with the highway cycle to determine compliance. "US: Light-duty: Fuel Economy and GHG," Transportpolicy.net, accessed September 25, 2024, https://www.transportpolicy.net/standard/us-light-duty-fuel-economy-and-ghg/.

14 Jörg Kühlwein, John German, and Anup Bandivadekar, *Development of Test Cycle Conversion Factors among Worldwide Light-duty Vehicle CO2 Emission Standards* (International Council on Clean Transportation, 2014), https://theicct.org/publication/development-of-test-cycle-conversion-factorsamong-worldwide-light-duty-vehicle-co2-emission-standards/; ZifeiYang, "Improving the Conversions Between the Various Passenger Vehicle Fuel Economy/CO2 Emission Standards Around the World," *International Council on Clean Transportation Staff Blog*, December 3, 2014, https://theicct.org/improving-the-conversions-between-the-variouspassenger-vehicle-fuel-economy-co2-emission-standards-around-the-world/.

**Figure 2**
**Light commercial vehicle $CO_2$ emissions**




*Notes:* UK fleet-average targets estimated based on non-ZEV $CO_2$ emissions and ZEV mandate.
Canada 2035 target is estimated based on Canada's 2035 ZEV mandate.
The U.S. 2027 target and beyond reflect the changes in the credits flexibilities including off-cycle and A/C credits.

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Among the major global markets, the European Union and United Kingdom have the most ambitious and far-reaching emission targets: 0 g $CO_2$/km limit, or 100% zero-emission sales requirement, by 2035. To catch up, Mexico would need to increase the stringency of its targets and set longer-term targets through 2035; this would allow automakers enough lead time to plan and would continue emission reductions beyond 2027. Furthermore, that the Phase 2 targets are set only through 2027 does not align with Mexico's 2030 vehicle electrification goal and the corresponding need for regulatory predictability to support manufacturer planning to meet the electrification goal.

## COMPLIANCE FLEXIBILITIES IN THE NOM 163 PHASE 2 STANDARDS

The Phase 2 standards allow flexibilities that include: (1) credits for "off-cycle" technologies that can reduce emissions during real-world driving and are not captured during type-approval test procedures; (2) credits for improvements in air conditioning (AC) systems that can reduce emissions; and (3) multipliers for highly efficient technologies pursuant to which vehicles of specific powertrains such as battery electric vehicles can be counted as more than one vehicle in a manufacturer's fleet. These types of credits and multipliers were adopted in other leading markets when $CO_2$ standards were introduced decades ago, to encourage early uptake of low- and zero-emission powertrains and spur innovation in off-cycle technologies that reduce emissions.

## Off-cycle technologies

For the mandatory Phase 2 compliance period from 2025 to 2027, off-cycle credits are offered for 10 types of technologies (Table 1); manufacturers may accumulate credits by integrating one or more of them but the total credits are capped at 6.25 g $CO_2$/km. The U.S. rule also offers off-cycle credits, but reduces them from 6.2 g $CO_2$/km in 2027 to 3.7 g $CO_2$/km in 2032 and they are phased out entirely in 2033.[15]

**Table 1**

**Off-cycle technology credits under Mexico's Phase 2 standard**

| Off-cycle technology | Passenger cars (g $CO_2$/km) | Light commercial vehicles (g $CO_2$/km) |
|---|---|---|
| **High-efficiency lighting** | Up to 0.91 | |
| **Waste heat recovery** | 1.55 | |
| **Active aerodynamic improvements** | Up to 1.20 | Up to 2.06 |
| **Engine idle start-stop** | 1.15 | 2.23 |
| **Active engine warm-up** | 1.10 | 2.34 |
| **Active transmission warm-up** | 1.21 | 2.58 |
| **Solar/thermal control** | Up to 2.70 | |
| **Solar roof panels (for 75W, battery charging only)** | Up to 2.00 | |
| **Tire pressure monitoring (mandatory from 2026)** | 0.60 | |
| **Heater circulation system** | 1.92 | 3.38 |

## Air conditioning

NOM 163 grants credits related to AC systems for improved efficiency depending on technologies and leakage reduction with or without replacement of refrigerant gases.[16] Credits are provided for eight types of technologies and sum up to 10.3 g $CO_2$/km for PCs and 14.67 g $CO_2$/km for LCVs. The credit related to leakage reduction without refrigerant change is 4.12 g $CO_2$/km, and the credit with refrigerant change is 9.04 g $CO_2$/km. Hence, the maximum possible credits for off-cycle and AC credits could be as high as 25.59 g $CO_2$/km for PCs, and 29.96 g $CO_2$/km for LCVs.

As most of the off-cycle and AC technologies eligible for credits in the Phase 2 standards are already widely available in the global markets, allowing credits could potentially over-credit the benefits and reduce the stringency level of the standards. Most leading markets have either already eliminated or are in the process of phasing out such credits in the next few years.[17] For example, the maximum possible $CO_2$ credits allowed in the Phase 2 standards are substantially higher than those in the U.S. 2027–2032 standards. The U.S. standards gradually reduce various $CO_2$ credits and lower the maximum possible credits between 2027 and 2033, from 16 g $CO_2$/km to 4 g $CO_2$/km for PCs and 19 g $CO_2$/km to 6 g $CO_2$/km for light trucks (in g/km equivalent units).[18]

15 Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles; Correction, 89 F.R. 115, June 13, 2024, https://www.govinfo.gov/content/pkg/FR-2024-06-13/pdf/2024-12590.pdf. We converted U.S. g/mi credits to g/km equivalent units for comparison.

16 Refrigerant gases need to be replaced with those that have a lower global warming potential (GWP) than the reference gas HFC-134a, which has GWP of 1,300.

17 International Council on Clean Transportation, "Passenger Vehicle Greenhouse Gas."

18 U.S. Environmental Protection Agency, "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles."

### Highly efficient technologies

The Phase 2 standards consider battery electric vehicles (BEVs), fuel-cell electric vehicles (FCEVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs) as "highly efficient" technologies. Manufacturers can count these vehicles multiple times when calculating their fleet averages, but only for domestically sold vehicles. The multipliers are 13.5 times for BEVs and FCEVs, 8.3 times for PHEVs, and 5 times for HEVs.

These multipliers are significantly higher than those in other countries, as shown in Table 2.[19] China and the United States are phasing out these multipliers starting in 2025, and the European Union eliminated them in 2023. Chile has the second largest multiplier values after Mexico, but the multipliers are capped at 3 compared with 13.5 and 8.3 in Mexico's Phase 2 standards. South Korea is the only major market that still offers a multiplier for sales of HEVs; it is offered through 2026, but is much lower—1.5 in 2025 and 1.25 in 2026—and will phase out entirely in 2027.

**Table 2**

**Multipliers provided under fuel economy/$CO_2$ standards in Mexico and other selected global markets**

| Country | Model years | Qualified vehicles | Multiplier |
|---|---|---|---|
| **México** | 2025–2027 | BEV/FCEV | 13.5 |
| | | PHEV | 8.3 |
| | | HEV | 5.0 |
| **Chile** | 2024–2030 | BEV/FCEV, PHEV | 3 |
| **United States** | 2023–2024 | BEV/FCEV | 1.5 |
| | | PHEV | 1.3 |
| | 2025 and later | All | 1 |
| **European Union** | 2021 | $CO_2$ < 50 g/km (NEDC) | 1.67 |
| | 2022 | | 1.33 |
| | 2023 and later | All | 1 |
| **China** | 2024 | BEV/FCEV, PHEV (mileage ≥ 43 km) | 1.3 |
| | | Non-EVs < 3.2 L/100 km | 1.1 |
| | 2025 and later | All | 1 |

*Source:* "Passenger Vehicle Greenhouse Gas Emissions and Fuel Consumption," International Council on Clean Transportation, updated August 2023, https://theicct.org/pv-fuel-economy/.

Given the significantly higher magnitude of these Phase 2 multipliers compared with those in other countries, and their potential to allow large credits for automakers with relatively low EV sales, their primary effect is arguably going to be significant reduction in the overall stringency of the emissions standard, rather than acceleration of EV adoption.[20]

19 International Council on Clean Transportation, "Passenger Vehicle Greenhouse Gas."

20 Kenneth Gillingham, *Designing Fuel-Economy Standards in Light of Electric Vehicles [Working Paper No. 29067]* (National Bureau of Economic Research, 2021). https://www.nber.org/papers/w29067.

# METHOD OF ANALYSIS

We developed six policy scenarios to evaluate the $CO_2$ emissions impact of different regulatory pathways for Mexico's new LDVs. We used the ICCT's Roadmap Model to estimate the real-world representative well-to-wheel (WTW) $CO_2$ emissions for the six scenarios we developed.[21] The WTW emission estimates include emissions from vehicle operation and from fuel production, processing, distribution, and use.[22] Thus, WTW emissions account for the vehicle emissions from on-road driving as well as emissions from the production of fuel or electricity used to power internal combustion engine (ICE) vehicles and EVs.

## OVERVIEW OF POLICY SCENARIOS

In addition to a Baseline scenario, we developed two scenarios to reflect different variants of the adopted Phase 2 standards, and three others to reflect more ambitious emission targets. The ambitious scenarios align with either Mexico's 2030 electrification target or the U.S. 2027–2032 $CO_2$ standards. Each scenario includes PCs and LCVs, and goes from a base year through 2050. The most recent year for which Mexico's LDV type-approval $CO_2$ emissions data are available, 2016, is used as the base year.[23] The projections of total vehicle sales, vehicle stock, vehicle activity, and the carbon intensity of Mexico's electricity grid are the same for all scenarios.[24] Each policy scenario corresponds to a projection for annual EV uptake and reduction in ICE vehicle emissions and additional details for each are below.

**Baseline**: Business-as-usual (BAU) scenario with no mandatory $CO_2$ emission standards from 2016.

**Phase 2 Standards with All Credits and Multipliers**: Reflects the impact of the Phase 2 standards as currently adopted for 2025–2027 and assumes manufacturers take full advantage of the off-cycle and AC credits and the EV multipliers.

**Phase 2 Standards with Multipliers**: Assumes EV multipliers are retained but manufacturers are not awarded off-cycle or AC credits. This is to show the relative impact of the off-cycle and AC credits.

**2030 EV Sales Target with BAU ICE Emissions**: Aligns with Mexico's electrification commitments to achieve 50% EV sales by 2030 and 100% ZEV sales by 2040, without ICE technology improvement beyond the BAU level.[25]

**2030 EV Sales Target with ICE Improvement**: Assumes ICE emission reductions at 3% per year in addition to meeting the electrification targets.

21 ICCT Roadmap model version 2.3, (2024), https://theicct.github.io/roadmap-doc/versions/v2.3/.

22 "Emissions from Electric Vehicles," U.S. Department of Energy. Alternative Fuels Data Center, accessed on December 5, 2022, https://afdc.energy.gov/vehicles/electric_emissions.html#:~:text=Well%2Dto%2Dwheel%20 emissions%20include,and%20burning%20it%20in%20vehicles.

23 SEMARNAT, *MIR de Alto Impacto con Análisis de Riesgos y Análisis de Impacto en el Comercio Exterior del Proyecto de Norma Oficial Mexicana* [High Impact MIR with Risk Analysis and Impact Analysis on Foreign Trade] (2024), https://www.cofemersimir.gob.mx/mirs/55227.

24 Instituto Nacional de Estadística, Geografía e Informática, "Registro Administrativo de la Industria Automotriz de Vehículos Ligeros"; Secretaría de Energía, "Programa de Desarrollo del Sistema Eléctrico Nacional 2023-2037 [National Electrical System Development Program 2023-2037]," May 29, 2023, https://www.gob.mx/sener/articulos/programa-de-desarrollo-del-sistema-electrico-nacional-2023-2037.

25 We assume Mexico's 2030 electrification target incorporates flexibility by including PHEVs and BEVs, thereby making this interim 50% sales target for "EVs" rather than ZEVs strictly. The assumption aligns with many leading markets that have adopted similar targets, with intermediate EV sales goals preceding their ultimate transition to 100% ZEVs or a complete phaseout of internal combustion engines.

**U.S. Targets Aligned**: Aligns with the U.S. $CO_2$ 2027–2032 targets as originally proposed and assumes 100% ZEV sales by 2040.[26]

## SCENARIO ASSUMPTIONS AND ESTIMATION

The Baseline scenario, which has no emission standards, assumes a minimal increase in annual EV sales shares and a conservative 1% annual rate of ICE emission reductions from 2017 to 2050. The growth in annual EV shares is based on anticipated EV uptake in developing countries with improvement in the relative economic benefits of EVs compared with ICE vehicles.[27] The annual 1% ICE efficiency improvement is based on Mexico's type-approval $CO_2$ emissions from 2008 to 2012, before the standards were introduced (see detailed assumptions in Table A1 and Table A2 in Appendix A).

For all five non-baseline scenarios, we assume standards take effect starting in 2025. All projections and assumptions before 2025 remain the same as the Baseline across all scenarios.

For the 2030 EV Sales Target with ICE Improvement and U.S. Targets Aligned scenarios, we assume a 3% annual rate of ICE emission reductions for the standard period. The 3% rate is based on a prior ICCT study and is consistent with reduction rates for European ICE passenger cars in the 2021–2025 time frame.[28] This rate also aligns with observed rates from type-approval tests in France (3.9%), Germany (2.3%), and United Kingdom (3.3%) in the 2019–2022 time frame. We further assume that ICE emissions will decrease 1% annually, as in the Baseline scenario, after the standard period ends and until the BEV sales share reaches 100%.

For the Phase 2 Standards with Multipliers and U.S. Targets Aligned scenarios, we calculate the annual EV sales shares needed to comply with the fleet-average targets after accounting for the projected performance of new ICE vehicles during the years of the standard. In the Phase 2 Standards with All Credits and Multipliers scenario, the targets are so lenient that they would lead to EV shares below the BAU level. Thus, for this scenario, we fix the EV shares at BAU levels and estimate the performance improvements of new ICE vehicles needed to comply with the standards. In this case, because the minimal baseline EV shares would already be sufficient to meet the Phase 2 targets without any ICE improvement, the performance of ICE vehicles could be even worse than the Baseline and still comply with the Phase 2 standard.

For the Phase 2 Standards with Multipliers scenario, the stringency level of the 2027 target could result in a slightly higher EV share than the BAU. Thus, for this scenario, post-2027 EV shares are projected to grow at a slightly faster rate than the BAU level.

26 Proposed Rule: Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles, 88 F.R. 29184 (proposed May 5, 2023), https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-multi-pollutant-emissions-standards-model. The proposed U.S. targets were slightly more ambitious than the finalized targets, except for 2032, for which the final targets are the same as proposed. The EV shares we estimate using the proposed targets in the fleet-average equation are not significantly different from those based on the final targets. Hence, we keep the stringency level of the proposed targets and the respective EV shares for this scenario.

27 The minimal EV shares assumption is in line with a baseline scenario for global vehicle markets' minimum EV sales shares, taken from Arijit Sen and Josh Miller, *Emissions Reduction Benefits of a Faster, Global Transition to Zero-emission Vehicles* (International Council on Clean Transportation, 2022), https://theicct.org/publication/zevs-global-transition-benefits-mar22/.

28 Peter Mock and Sonsoles Díaz, *Pathways to Decarbonization: The European Passenger Car Market in the Years 2021–2035* (International Council on Clean Transportation, 2021), https://theicct.org/publication/pathways-to-decarbonization-the-european-passenger-car-market-2021-2035/.

For the 2030 EV Sales Target scenarios, we defined the trajectory of EV sales shares needed to reach the target and separately specified the assumptions for new ICE vehicle performance.

For all scenarios, we also assume PHEV efficiency improvement until 2035, when BEVs become the dominant technology. The annual rates of $CO_2$ emissions reduction from PHEVs are 2% from 2020 to 2025, 1% from 2026 to 2035, and 0% post-2035. These assumptions align with prior ICCT estimates for the EU car market and are consistent across all scenarios.[29]

None of the modeling includes HEVs as a separate technology from ICE and thus the analysis does not account for the effect of HEV multipliers in the Phase 2 standards. Accounting for the HEV multipliers would further lower the rate of EV uptake and ICE improvement needed to comply with the Phase 2 standards.

Furthermore, the BEV share of EV sales grows substantially faster than the PHEV share until reaching the 100% BEV target by 2040 (see detailed assumption in Table A5 in Appendix A). The BEV and PHEV sales shares from 2019 to 2022 are based on actual sales data of those years.[30]

Each scenario's historical and projected vehicle $CO_2$ emissions are calculated using ICCT's Roadmap Model. Historical emissions are calculated based on historical data on vehicle sales, used vehicle imports, vehicle stock, vehicle activity, energy intensity, and fuel carbon intensity. Historical sales data was taken from Mexico's Administrative registry of the light vehicle automotive industry.[31] Sales shares for used vehicle imports were modeled using a combination of data from the U.S. Environmental Protection Agency and the United Nations Environment Programme.[32] Historical vehicle stock and activity data were taken from the International Energy Agency.[33] Projected emissions were calculated based on stock turnover, vehicle activity projections from the International Energy Agency, and scenario inputs including the annual EV sales shares and annual ICE emissions reduction relative to 2016 $CO_2$ emissions. The model estimates stock turnover based on survival curves derived from the International Energy Agency's historical data on vehicle sales and stock in Mexico.[34]

As the energy mix of the electricity grid determines the WTW emissions for EVs, the model inputs for Mexico's electricity grid emission factors were taken from the Ministry of Energy's *National Electrical System Development Program 2023-2037*.[35]

29 Mock and Díaz, *Pathways to Decarbonization*.

30 Instituto Nacional de Estadística, Geografía e Informática, "Registro Administrativo de la Industria Automotriz de Vehículos Ligeros."

31 Instituto Nacional de Estadística, Geografía e Informática, "Registro Administrativo de la Industria Automotriz de Vehículos Ligeros."

32 U.S. Environmental Protection Agency, "Official Release of the MOVES3 Motor Vehicle Emissions Model for SIPs and Transportation Conformity," FRL-10016-84-OAR, https://www.federalregister.gov/documents/2021/01/07/2021-00023/official-release-of-the-moves3-motor-vehicle-emissions-model-for-sips-and-transportation-conformity; UN Enviroment Programme, *Used Vehicles* and *the Environment - Progress* and *Updates* 2021 (2021), https://www.unep.org/resources/report/used-vehicles-and-environment-progress-and-updates-2021.

33 International Energy Agency, *World Energy Outlook 2020* (2020), https://www.iea.org/reports/world-energy-outlook-2020.

34 International Energy Agency, *World Energy Outlook 2020*.

35 Secretaría de Energía, "Programa de Desarrollo del Sistema Eléctrico Nacional 2023-2037 [National Electrical System Development Program 2023-2037]," (2023), https://www.gob.mx/sener/articulos/programa-de-desarrollo-del-sistema-electrico-nacional-2023-2037.

## SCENARIO RESULTS

Figure 3 shows key elements of each scenario for PCs and LCVs and illustrates the trajectories over time for different stringency levels for each policy scenario. The underlying data are given in Table A3 and Table A4 in Appendix A. Note that although the figures reflect the potential technical pathways to meet standards for this analysis, in practice, manufacturers can meet fleet-average targets through various combinations of improved ICE technologies and increased EV sales.

**Figure 3**

**Emissions and EV sales shares for passenger cars and light commercial vehicles under the six scenarios**


*Note:* For charts with ICE emissions and EV shares, a few scenario lines overlap (and hence, are not visible) due to shared assumptions.

The Baseline scenario, assuming a 3% EV sales share and a 13% emissions reduction from ICE vehicles in 2030 compared with the 2016 level, results in fleet-average emissions of 118 g $CO_2$/km for PCs and 175 g $CO_2$/km for LCVs; these are only 15% below the respective 2016 baseline levels.

The Phase 2 Standards with All Credits and Multipliers scenario is not projected to drive any increase in EV uptake or reduction of ICE emissions from the Baseline scenario. Instead, this scenario allows for 10% higher ICE emissions for PCs and 8% higher emissions for LCVs in 2025 compared with 2016 levels.

The Phase 2 Standards with Multipliers scenario leads to reductions in fleet-average emissions of 12% for PCs and 10% for LCVs in 2025 compared with 2016 levels. However, these reductions are only marginally better than the Baseline scenario. Neither of the Phase 2 Standard scenarios would achieve close to the 50% EV sales by 2030 target; even if manufacturers do not take full advantage of the off-cycle and AC credits, manufacturers could still comply in 2030 with PC and LCV EV sales shares of well below 10%.

To achieve the 50% EV sales target by 2030, assuming no ICE improvement beyond the BAU rate of 1% per year, the fleet-average g $CO_2$/km emissions target would need to be tightened by more than 50% in 2030 compared with 2016.

Additionally, achieving the 50% EV sales target by 2030 and improving ICE efficiency at a rate of 3% per year would require setting a fleet-average target that is similar in stringency to the originally proposed U.S. targets: fleet-average emissions reduction by 56% for PCs (versus 60% in the U.S. Targets Aligned scenario) and 61% for LCVs (versus 67% in the U.S. Targets Aligned scenario), compared with the 2016 levels.

## $CO_2$ EMISSION IMPACTS

Figure 4 illustrates the projected annual WTW $CO_2$ emission impacts for Mexico's LDV stock under each scenario from 2024 to 2050. The labels show the estimated cumulative emissions from 2024 through 2050 and the percentage difference in cumulative emissions for each scenario relative to the Baseline scenario. Annual and cumulative emissions for each scenario can be found in Table B1 of Appendix B.

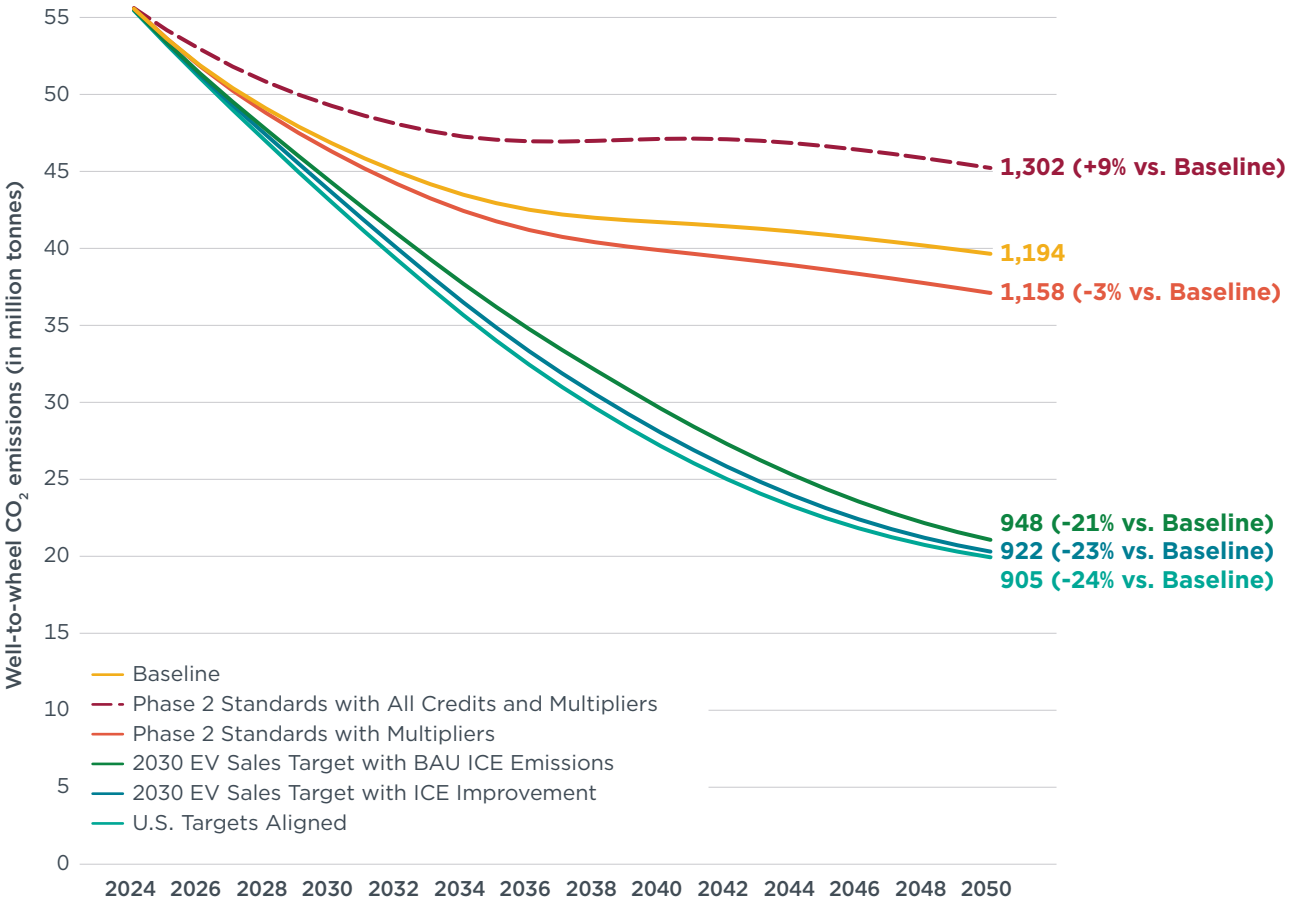
In the Baseline scenario, emissions are reduced by 29% in 2050 to 40 million tonnes compared with the pre-standard 2024 level of 56 million tonnes. The cumulative emissions from 2024 through 2050 are projected to be 1,194 million tonnes.

The Phase 2 Standards with All Credits and Multipliers could potentially allow higher emissions in 2050 relative to the Baseline scenario, and result in 12% higher annual emissions and 9% higher cumulative emissions. The Phase 2 Standards with Multipliers scenario would be marginally better than the Phase 2 Standards with All Credits and Multipliers scenario, leading to only 6% lower emissions and 3% lower cumulative emissions in 2050 relative to the Baseline scenario.

The other three policy scenarios could result in much larger emission reductions. All three could lead to a 50% emissions reduction in 2050 and a 21%–24% reduction in cumulative emissions through 2050 compared with the Baseline. Furthermore, each of these could reduce emissions by more than 60% in 2050 compared with the 2024 level. The U.S. Targets Aligned scenario would yield the lowest cumulative emissions across the scenarios, at 905 million tonnes through 2050, a reduction of nearly 300 million tonnes from the Baseline scenario.

**Figure 4**

**Projected annual well-to-wheel $CO_2$ emissions (million tonnes) from Mexico's light-duty vehicle stock for each policy scenario from 2024 to 2050**




*Note:* Data labels show cumulative emissions from 2024 to 2050.

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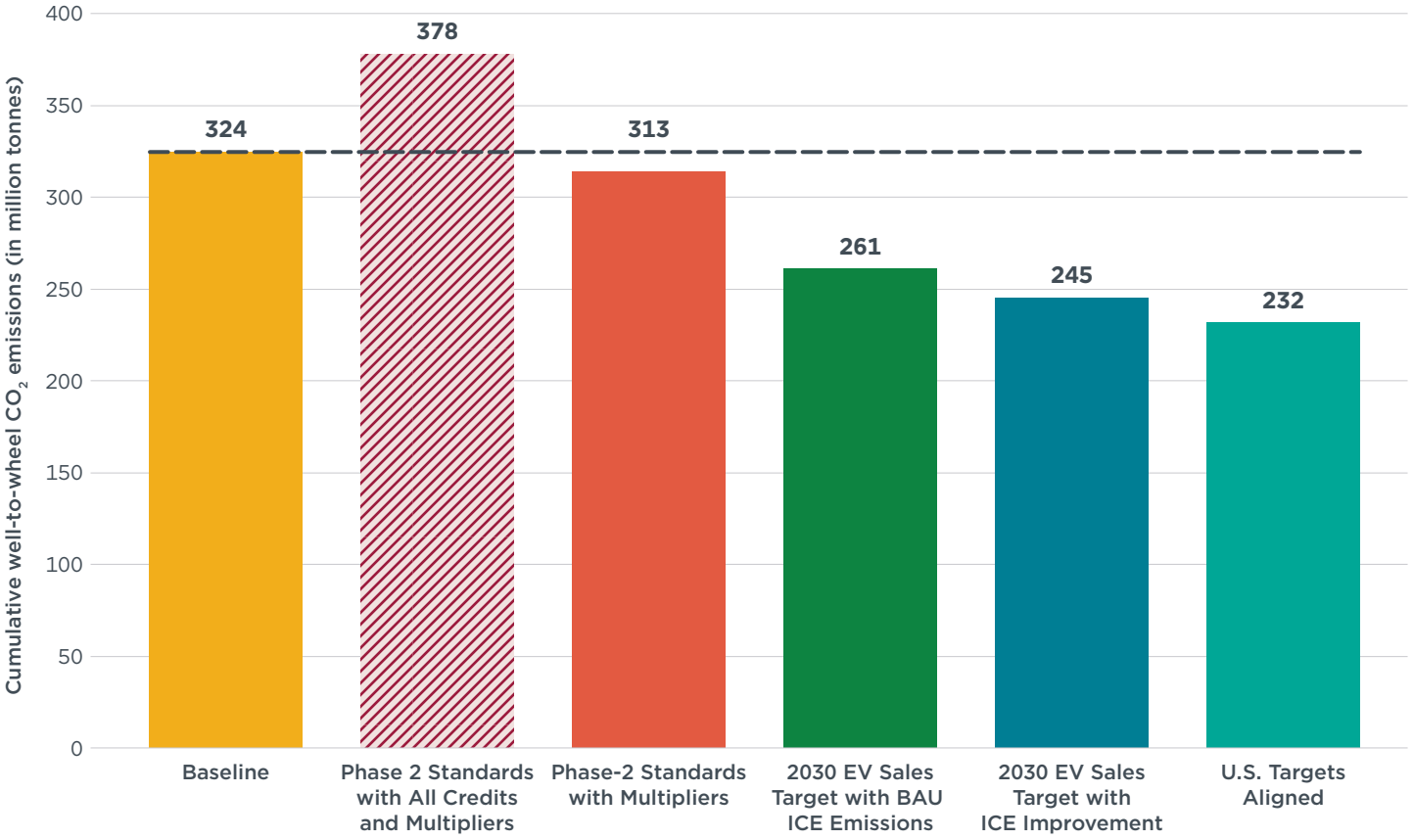
The latest U.S. standards set increasingly more stringent targets through model year 2032. To isolate the emission impacts of policy decisions in Mexico that affect vehicles sold between 2025 and model year 2032,  shows the cumulative WTW $CO_2$ emissions through 2050 from vehicles sold during this time frame. If Mexico were to retain the current Phase 2 Standards without modification, we estimate that 54 million additional tonnes of $CO_2$ would be emitted from model year 2025–2032 vehicles. In contrast, aligning with the stringency of the originally proposed U.S. targets would avoid 92 million tonnes of $CO_2$ emissions from model year 2025–2032 vehicles.

**Figure 5**

**Cumulative well-to-wheel $CO_2$ emissions through 2050 from light-duty vehicles sold in Mexico, for model years 2025–2032**

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## CONCLUSIONS

This work evaluated the impact of $CO_2$ emission standards of different stringency levels for LDVs in Mexico. We modeled the impact of the currently adopted Phase 2 NOM 163 standards to estimate if the standards can drive ICE technology advancement or EV uptake and significantly reduce $CO_2$ emissions. We also modeled several alternate scenarios that can help Mexico achieve its electrification target by 2030. Our key findings include:

**The current Phase 2 standards do not align with Mexico's electrification and climate targets**. If manufacturers use the maximum allowable off-cycle and AC credits provided under the standards, there is no need to reduce emissions from ICE vehicles or increase EV uptake compared with a BAU scenario to comply with the standards. Instead, the Phase 2 standards could potentially allow an *increase* of $CO_2$ emissions from ICE vehicles compared with the Baseline scenario. If that happens, the Phase 2 standards would allow for 108 million tonnes more cumulative emissions than the Baseline scenario from 2024 through 2050. Even without the off-cycle and AC credits, the standards would only drive a minimal increase in EV uptake of 5% by 2030 due to the multipliers awarded for sales of BEVs and PHEVs. Thus, both the design and stringency of the Phase 2 standard would need to be revised to support Mexico

achieving 50% EV sales by 2030 and to align with the GHG emissions reduction commitment set in its Nationally Determined Contribution.

**To achieve 50% EV sales by 2030 and significant $CO_2$ reductions, standards would need to require between a 50% and 70% reduction in fleet-average emissions in 2030 compared with 2016 levels,** depending on whether manufacturers further improve ICE vehicle performance or focus solely on increasing EV uptake. Three of the scenarios—2030 EV Sales Target with BAU ICE Emissions, 2030 EV Sales Target with ICE Improvement, and U.S. Targets Aligned—are all sufficient to meet the 50% EV sales target by 2030 and would drive substantial $CO_2$ reductions. The U.S. Targets Aligned scenario is the most ambitious; it would lead to the largest cumulative emission reductions of nearly 300 million tonnes through 2050, and EV sales shares of more than 50% (56% for PCs and 58% for LCVs) in 2030. Fleet-average emission targets in this scenario are 57 g $CO_2$/km for PCs (60% reduction from 2016) and 68 g $CO_2$/km for LCVs (67% reduction from 2016) in 2030.

**Setting a less-stringent standard that aligns with the 50% EV target but only with little improvement in ICE performance, could risk not meeting the EV target.** The 2030 EV Target with BAU ICE Emissions scenario would require fleet-average targets of 69 g $CO_2$/km for PCs and 91 g $CO_2$/km for LCVs in 2030. Although such a scenario could be achieved with a 50% EV sales share by 2030, manufacturers could also opt to reduce ICE emissions to help comply with the standards, and this would lead to a lower EV sales share.

**Assuming the same rates of ICE performance improvement seen in other major markets could increase the certainty of Mexico achieving its electrification target by 2030 and support energy security.** The 2030 EV Target with ICE Improvement scenario could be achieved by setting fleet-average targets of 62 g $CO_2$/km for PCs and 81 g $CO_2$/km for LCVs in 2030. These targets would lead to 56%–61% reduction in fleet-average emissions from the 2016 baseline and reduce cumulative $CO_2$ emissions through 2050 by 272 million tonnes relative to the Baseline scenario. A further 17 million tonnes of $CO_2$ could be avoided by fully aligning with the stringency of the originally proposed U.S. standards. Improving the efficiency of gasoline vehicles would result in savings for consumers and reduce the need to import fossil fuels.

# APPENDIX A

**Table A1**

**Scenario assumptions for passenger cars**

| Scenario | EV sales shares[a] | | | | | Annual reduction in $CO_2$ emissions | |
|---|---|---|---|---|---|---|---|
| | 2025 | 2030 | 2035 | 2040 | 2050 | ICEV | PHEV[b] |
| **Baseline** | 2%[c] | 3% | 5% | 8% | 20% | 1% (2017–2050)[d] | 2% (2020–2025)[e] 1% (2026–2035) 0% post 2035 |
| **Phase 2 Standards with All Credits and Multipliers[f]** | 2%[g] | 3% | 5% | 8% | 20% | 1% (2017–2024) Estimated (2025–2027) 1% (2028–2050) | |
| **Phase 2 Standards with Multipliers[h]** | 2%[i] | 5% | 8% | 13% | 28% | 1% (2017–2024) Estimated (2025–2026) 3% (2027) 1% (2028–2050) | |
| **2030 EV Sales Target with BAU ICE Improvement** | 10%[j] | 50%[k] | 75%[l] | 100%[m] (BEV) | 100% (BEV) | 1% (2017–2050) | |
| **2030 EV Sales Target with ICE Improvement** | 10% | 50% | 75% | 100% (BEV) | 100% (BEV) | 1% (2017–2024) 3% (2025–2039) 0% post 2039[n] | |
| **U.S. Targets Aligned** | 14%[o] | 56%[p] | 77%[q] | 100% (BEV) | 100% (BEV) | 1% (2017–2024) 3% (2025–2039) 0% post 2039 | |

[a] Includes BEVs and PHEVs unless otherwise noted

[b] Assumptions for PHEV $CO_2$ emissions reduction are taken from Peter Mock and Sonsoles Díaz, Pathways to Decarbonization: The European Passenger Car Market in the Years 2021–2035 (International Council on Clean Transportation, 2021), https://theicct.org/publication/pathways-to-decarbonization-the-european-passenger-car-market-2021-2035/.

[c] Based on minimum EV sales share assumptions for major markets from Arijit Sen and Josh Miller, Emissions Reduction Benefits of a Faster, Global Transition to Zero-emission Vehicles (International Council on Clean Transportation, 2022), https://theicct.org/publication/zevs-global-transition-benefits-mar22/.

[d] Historical data from pre-standards years (i.e., 2008–2011) shows roughly 2% annual emissions reduction on average; 1% rate is a conservative assumption to account for the actual reduction in the real world. The year 2016 is assumed as the baseline year because that is the latest year for which $CO_2$ emissions type-approval data are available for Mexico.

[e] PHEV sales were assumed to be zero before 2020.

[f] Total $CO_2$ emissions credits allowed for the Phase 2 2025–2027 standards were added to the enacted targets: AC credits for leakage reduction with refrigerant change, a cap for AC efficiency and off-cycle credits, and we accounted for EV multipliers in the fleet-average equation.

[g] Assumed minimal baseline EV shares since EV shares become theoretically zero if estimated from fleet-average targets added with all credits/multipliers; instead, we estimate 2025–2027 ICE emissions as a function of baseline EV shares and fleet-average targets with all credits/multipliers.

[h] EV multipliers: 13.5 for BEVs, 8.3 for PHEVs

[i] Assumed baseline EV sales shares for 2025–2026 but estimated slightly higher EV share in 2027, to limit the need for annual ICE efficiency improvement to 3% to meet the 2027 target. ICE emissions for 2025–2026 and EV share for 2027 were estimated using only EV multipliers in the fleet-average equation. Post-2027 EV shares were assumed to grow at slightly faster pace than baseline scenario.

[j] 2025 EV shares interpolated between 2024 and 2030 shares

[k] Mexico's electrification target by 2030

[l] 2035 EV share interpolated between 2030 and 2040 shares.

[m] Mexico's COP26 commitment as an emerging market signatory to global ZEV Declaration for transition to 100% zero-emission vehicles globally by 2040

[n] Standards are assumed to continue reducing ICE emissions 3% per year through 2039 before phasing out ICE vehicles in 2040

[o] 2025 EV share interpolated between 2024 and 2026 shares

[p] Derived: EV sales shares calculated for 2026–2032 using the U.S. proposed targets and assumed ICE efficiency improvement in the fleet-average equation

[q] 2035 EV share for U.S. Targets Aligned Scenario interpolated between 2032 and 2040 shares

**Table A2**

**Scenario assumptions for light commercial vehicles**

| Scenario | EV sales shares | | | | | Annual reduction in $CO_2$ emissions | |
|---|---|---|---|---|---|---|---|
| | 2025 | 2030 | 2035 | 2040 | 2050 | ICEV | PHEV |
| **Baseline** | 2% | 3% | 5% | 8% | 20% | 1% (2017–2050) | 2% (2020–2025)<br>1% (2026–2035)<br>0% post 2035 |
| **Phase 2 Standards with All Credits and Multipliers** | 2% | 3% | 5% | 8% | 20% | 1% (2017–2024)<br>Estimated (2025–2027)<br>1% (2028-2050) | |
| **Phase 2 Standards with EV Multipliers** | 2% | 5% | 8% | 13% | 28% | 1% (2017–2024)<br>Estimated (2025–2026)<br>3% (2027)<br>1% (2028–2050) | |
| **2030 EV Sales Target with BAU ICE Emissions** | 10% | 50% | 75% | 100% (BEV) | 100% (BEV) | 1% (2017–2050) | |
| **2030 EV Sales Target with ICE Improvement** | 10% | 50% | 75% | 100% (BEV) | 100% (BEV) | 1% (2017–2024)<br>3% (2025–2039)<br>0% post 2039 | |
| **U.S. Targets Aligned** | 15% | 58% | 77% | 100% (BEV) | 100% (BEV) | 1% (2017–2024)<br>3% (2025–2039)<br>0% post 2039 | |

**Table A3**

**Summary of key elements in the scenarios: Passenger cars**

| Scenario | Scenario elements[a] | 2016 | 2025 | 2030 | 2035 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|
| Baseline | Fleet-average $CO_2$ emissions target (g/km) | 140 | 125 | 118 | 110 | 101 | 79 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 1.2% | 1.4% | 1.7% | 2.4% |
| | BEV sales share | ~0% | 1.1% | 1.8% | 4.0% | 8.0% | 20.0% |
| | PHEV sales share | ~0% | 0.9% | 1.2% | 1.0% | 0.0% | 0.0% |
| | Total EV share | ~0% | 2.0% | 3.0% | 5.0% | 8.0% | 20.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 140 | 128 | 121 | 115 | 110 | 99 |
| Phase 2 Standards with All Credits and Multipliers | Fleet-average $CO_2$ emissions target (g/km) | 140 | 154 | 135 | 125 | 115 | 90 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 2.6% | 1.4% | 1.7% | 2.4% |
| | BEV sales share | ~0% | 1.1% | 1.8% | 4.0% | 8.0% | 20.0% |
| | PHEV sales share | ~0% | 0.9% | 1.2% | 1.0% | 0.0% | 0.0% |
| | Total EV share | ~0% | 2.0% | 3.0% | 5.0% | 8.0% | 20.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 140 | 156 | 138 | 131 | 125 | 113 |
| Phase 2 Standards with Multipliers | Fleet-average $CO_2$ emissions target (g/km) | 140 | 123 | 109 | 101 | 90 | 67 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 2.3% | 1.7% | 2.2% | 2.9% |
| | BEV sales share | ~0% | 1.1% | 3.0% | 6.5% | 13.0% | 28.0% |
| | PHEV sales share | ~0% | 0.9% | 2.0% | 1.5% | 0.0% | 0.0% |
| | Total EV share | ~0% | 2.0% | 5.0% | 8.0% | 13.0% | 28.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 140 | 125 | 114 | 109 | 103 | 93 |
| 2030 EV Sales Target with BAU ICE Emissions | Fleet-average $CO_2$ emissions target (g/km) | 140 | 117 | 69 | 33 | 0 | 0 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 10% | 14% | 100% | — |
| | BEV sales share | ~0% | 5.9% | 30.4% | 65.2% | 100.0% | 100.0% |
| | PHEV sales share | ~0% | 4.0% | 19.6% | 9.8% | 0.0% | 0.0% |
| | Total EV share | ~0% | 9.9% | 50.0% | 75.0% | 100.0% | 100.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 140 | 128 | 121 | 115 | 111 | 111 |
| 2030 EV Sales Target with ICE Improvement | Fleet-average $CO_2$ emissions target (g/km) | 140 | 114 | 62 | 27 | 0 | 0 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 11.5% | 15.3% | 100.0% | — |
| | BEV sales share | ~0% | 5.9% | 30.4% | 65.2% | 100.0% | 100.0% |
| | PHEV sales share | ~0% | 4.0% | 19.6% | 9.8% | 0.0% | 0.0% |
| | Total EV share | ~0% | 9.9% | 50.0% | 75.0% | 100.0% | 100.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 140 | 125 | 107 | 92 | 82 | 82 |
| U.S. Targets Aligned | Fleet-average $CO_2$ emissions target (g/km) | 140 | 110 | 57 | 26 | 0 | 0 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 13% | 14% | 100% | — |
| | BEV sales share | ~0% | 8.0% | 34.0% | 64.6% | 100% | 100% |
| | PHEV sales share | ~0% | 6.1% | 21.9% | 12.3% | 0.0% | 0.0% |
| | Total EV share | ~0% | 14.1% | 55.9% | 77.0% | 100.0% | 100.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 140 | 125 | 107 | 92 | 82 | 82 |

[a] All $CO_2$ emissions estimates are based on the U.S. CAFE cycles

[b] Annual reductions for fleet-average targets are estimated from 2025 onward because the standards begin in 2025; for example, the rate for 2030 is the annual reduction rate from 2025 to 2030, and the rate for 2035 is the rate from 2030 to 2035, and so on. This formula was used for estimating annual average rates between time periods: 1-[(g/km emissions at end year/g/km emissions at start year)]^(1/(end year-start year))

## Table A4

**Summary of key elements in the scenarios: Light commercial vehicles**

| Scenario | Scenario elements[a] | 2016 | 2025 | 2030 | 2035 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|
| Baseline | Fleet-average $CO_2$ emissions target (g/km) | 207 | 186 | 175 | 163 | 150 | 118 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 1.2% | 1.4% | 1.6% | 2.4% |
| | BEV sales share | ~0% | 1.9% | 2.9% | 5.0% | 8.0% | 20.0% |
| | PHEV sales share | ~0% | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% |
| | Total EV share | ~0% | 2.0% | 3.0% | 5.0% | 8.0% | 20.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 207 | 189 | 180 | 171 | 163 | 147 |
| Phase 2 Standards with All Credits and Multipliers | Fleet-average $CO_2$ emissions target (g/km) | 207 | 224 | 200 | 186 | 171 | 135 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 2.3% | 1.4% | 1.6% | 2.4% |
| | BEV sales share | ~0% | 1.9% | 2.9% | 5.0% | 8.0% | 20.0% |
| | PHEV sales share | ~0% | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% |
| | Total EV share | ~0% | 2.0% | 3.0% | 5.0% | 8.0% | 20.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 207 | 229 | 206 | 196 | 186 | 168 |
| Phase 2 Standards with Multipliers | Fleet-average $CO_2$ emissions target (g/km) | 207 | 187 | 167 | 153 | 138 | 103 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 2.3% | 1.6% | 2.1% | 2.9% |
| | BEV sales share | ~0% | 1.9% | 4.8% | 7.9% | 13.0% | 28.0% |
| | PHEV sales share | ~0% | 0.1% | 0.2% | 0.1% | 0.0% | 0.0% |
| | Total EV share | ~0% | 2.0% | 5.0% | 8.0% | 13.0% | 28.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 207 | 191 | 175 | 167 | 158 | 143 |
| 2030 EV Sales Target with BAU ICE Emissions | Fleet-average $CO_2$ emission target (g/km) | 207 | 172 | 91 | 43 | 0 | 0 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 12% | 14% | 100% | — |
| | BEV sales share | ~0% | 9.1% | 48.0% | 74.0% | 100.0% | 100.0% |
| | PHEV sales share | ~0% | 0.4% | 2.0% | 1.0% | 0.0% | 0.0% |
| | Total EV share | ~0% | 9.6% | 50.0% | 75.0% | 100.0% | 100.0% |
| | $CO_2$ emission of ICEVs (g/km) | 207 | 189 | 180 | 171 | 165 | 165 |
| 2030 EV Sales Target with ICE Improvement | Fleet-average $CO_2$ emission target (g/km) | 207 | 168 | 81 | 35 | 0 | 0 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 13.6% | 15.5% | 100.0% | — |
| | BEV sales share | | 9.1% | 48.0% | 74.0% | 100.0% | 100.0% |
| | PHEV sales share | | 0.4% | 2.0% | 1.0% | 0.0% | 0.0% |
| | Total EV share | ~0% | 9.6% | 50.0% | 75.0% | 100.0% | 100.0% |
| | $CO_2$ emission of ICEVs (g/km) | 207 | 186 | 159 | 137 | 121 | 121 |
| U.S. Targets Aligned | Fleet-average $CO_2$ emissions target (g/km) | 207 | 158 | 68 | 32 | 0 | 0 |
| | Average annual reduction in fleet-average $CO_2$ emissions[b] | — | — | 16% | 14% | 100% | — |
| | BEV sales share | ~0% | 14.4% | 55.6% | 76.2% | 100.0% | 100.0% |
| | PHEV sales share | ~0% | 0.9% | 2.3% | 1.2% | 0.0% | 0.0% |
| | Total EV share | ~0% | 15.3% | 58.0% | 77.4% | 100.0% | 100.0% |
| | $CO_2$ emissions of ICEVs (g/km) | 207 | 186 | 159 | 137 | 121 | 121 |

[a] All $CO_2$ emissions estimates are based on the U.S. CAFE cycles

[b] Annual reductions for fleet-average targets are estimated from 2025 onward because the standards begin in 2025; for example, the rate for 2030 is the annual reduction rate from 2025 to 2030, and the rate for 2035 is from 2030 to 2035, and so on. This formula was used for estimating annual average rates between time periods: 1-[(g/km emissions at end year/g/km emissions at start year)]^(1/(end year-start year))

**Table A5**

**BEV and PHEV split shares by vehicle type and year (split shares for 2023–2039 are assumed)**

| Year | Passenger cars | | Light commercial vehicles | |
|---|---|---|---|---|
| | BEV to EV share | PHEV to EV share | BEV to EV share | PHEV to EV share |
| 2019 | 21% | 79% | 12% | 88% |
| 2020 | 14% | 86% | 54% | 46% |
| 2021 | 23% | 77% | 67% | 33% |
| 2022 | 40% | 60% | 88% | 12% |
| 2023 | 54% | 46% | 93% | 7% |
| 2024 | 55% | 45% | 93% | 7% |
| 2025 | 56% | 44% | 94% | 6% |
| 2026 | 57% | 43% | 94% | 6% |
| 2027 | 58% | 42% | 95% | 5% |
| 2028 | 59% | 41% | 95% | 5% |
| 2029 | 60% | 40% | 96% | 4% |
| 2030 | 61% | 39% | 96% | 4% |
| 2031 | 65% | 35% | 97% | 3% |
| 2032 | 69% | 31% | 97% | 3% |
| 2033 | 73% | 27% | 98% | 2% |
| 2034 | 77% | 23% | 98% | 2% |
| 2035 | 81% | 19% | 99% | 1% |
| 2036 | 85% | 15% | 99% | 1% |
| 2037 | 89% | 11% | 100% | 0% |
| 2038 | 93% | 7% | 100% | 0% |
| 2039 | 97% | 3% | 100% | 0% |
| 2040 | 100% | 0% | 100% | 0% |
| 2041 | 100% | 0% | 100% | 0% |
| 2042 | 100% | 0% | 100% | 0% |
| 2043 | 100% | 0% | 100% | 0% |
| 2044 | 100% | 0% | 100% | 0% |
| 2045 | 100% | 0% | 100% | 0% |
| 2046 | 100% | 0% | 100% | 0% |
| 2047 | 100% | 0% | 100% | 0% |
| 2048 | 100% | 0% | 100% | 0% |
| 2049 | 100% | 0% | 100% | 0% |
| 2050 | 100% | 0% | 100% | 0% |

# APPENDIX B

**Table B1**

**Annual and cumulative $CO_2$ emissions for the modeled scenarios**

| Scenario | Frequency | $CO_2$ emissions (million tonnes) | | | | | | | | | | | | | Difference in 2050 versus Baseline | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2050 | Total (million tonnes) | % |
| Baseline | Annual | 56 | 54 | 52 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 43 | 40 | 0 | 0.0 |
| | Cumulative | 56 | 109 | 161 | 212 | 261 | 309 | 355 | 401 | 446 | 490 | 534 | 577 | 1,194 | 0 | 0.0 |
| Phase 2 Standards with All Credits and Multipliers | Annual | 56 | 54 | 53 | 52 | 51 | 50 | 49 | 49 | 48 | 48 | 47 | 47 | 45 | 6 | 14.1 |
| | Cumulative | 56 | 110 | 163 | 215 | 265 | 315 | 365 | 413 | 461 | 509 | 556 | 603 | 1,302 | 108 | 9.0 |
| Phase 2 Standards with Multipliers | Annual | 56 | 54 | 52 | 50 | 49 | 48 | 46 | 45 | 44 | 43 | 42 | 42 | 37 | (3) | (6.4) |
| | Cumulative | 56 | 109 | 161 | 211 | 260 | 308 | 354 | 399 | 443 | 487 | 529 | 571 | 1,158 | (37) | (3.1) |
| 2030 EV Sales Target with BAU ICE Emissions | Annual | 56 | 53 | 51 | 50 | 48 | 46 | 44 | 43 | 41 | 39 | 38 | 36 | 21 | (19) | (46.8) |
| | Cumulative | 56 | 109 | 160 | 210 | 258 | 304 | 348 | 390 | 431 | 471 | 508 | 545 | 948 | (246) | (20.6) |
| 2030 EV Sales Target with ICE Improvement | Annual | 56 | 53 | 51 | 49 | 47 | 46 | 44 | 42 | 40 | 38 | 37 | 35 | 20 | (19) | (48.8) |
| | Cumulative | 56 | 109 | 160 | 209 | 257 | 302 | 346 | 388 | 428 | 466 | 503 | 537 | 922 | (273) | (22.8) |
| U.S. Targets Aligned | Annual | 55 | 53 | 51 | 49 | 47 | 45 | 43 | 41 | 39 | 37 | 36 | 34 | 20 | (20) | (49.7) |
| | Cumulative | 55 | 109 | 160 | 209 | 256 | 301 | 344 | 385 | 424 | 462 | 497 | 531 | 905 | (289) | (24.2) |

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