




WHITE PAPER

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VISION 2050: UPDATE ON THE GLOBAL ZERO-EMISSION VEHICLE TRANSITION IN 2023

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EXECUTIVE SUMMARY

An accelerated global transition to 100% zero-emission vehicles (ZEVs) for sales of new cars, vans, buses, and trucks is a strategy being considered by policymakers globally to help limit warming to well below 2°C. To inform efforts of the member governments of the Zero Emission Vehicles Transition Council (ZEVTC), the ICCT published an analysis of the impacts of adopted, proposed, and ambitious ZEV policy pathways to reduce global vehicle carbon dioxide (CO₂) emissions in March 2022; it found that if major markets reach 100% ZEVs for sales of new light-duty vehicles (LDVs) by 2035 and new heavy-duty vehicles (HDVs) by 2040, and all other countries follow suit within 5 to 10 years, it is possible to put the sector on a pathway consistent with keeping warming below 2°C. This assumed that vehicles use up a proportional share—21%—of the remaining anthropogenic carbon budget. The study also found a substantial gap between the ambition announced by most vehicle markets and the ambition needed to align with the best chances of limiting warming to 1.5°C.

This study updates that 2022 study in several important ways, including by moving the policy cutoff from August 2021 to March 2023 and expanding the regional scope beyond ZEVTC markets and China for modeling policy developments. We incorporated ZEV and electric vehicle (EV) targets in ASEAN, Latin American countries other than Mexico, Australia and New Zealand, South Asian countries other than India, and selected markets in the Middle East and Africa. The modeling also considers international commitments from the Accelerating to Zero Coalition (ZEV Declaration) and the Global Memorandum of Understanding on Zero-Emission Medium- And Heavy-Duty Vehicles (Global MOU on ZE MHDVs). Additionally, sales, stock, and activity data were updated to include historical 2021 and some 2022 data, whereas the 2022 study included historical data through 2020. Sales, stock, and activity projections were also updated based on the most recent available information.

Table ES-1 highlights major policy developments between August 2021 and March 2023 and their impact on cumulative CO₂ emissions mitigation between 2023 and 2050. The policy developments included in the table are those that are expected to reduce emissions by around 1 gigatonne (Gt) or more. All these developments have occurred since August 2021, except for national policies modeled for the first time in Latin America (excluding Mexico), ASEAN, and other non-ZEVTC Asia Pacific countries, and subnational policies modeled for India and China. Any region's policy proposals that are modeled for the first time include "Consideration of" in the "Policy development" column of the table. In all, we modeled policy actions from 72 countries that account for 87% of new vehicle sales globally.

Table ES-1. Major policy developments between August 2021 and March 2023 that avoid at least around 1 Gt CO₂ cumulatively compared to the 2022 study scenarios.

Market	Policy development	Cumulative Gt CO ₂ avoided 2023-2050 compared to the 2022 study
Recently adopted policies and market developments <i>(updated Baseline scenario compared with the Baseline scenario in the 2022 study): 16.8 Gt</i>		
United States	State-level adoption of California's Advanced Clean Cars II (ACC II), Advanced Clean Trucks (ACT), and Advanced Clean Fleets (ACF) regulations; projected market growth under the Inflation Reduction Act; and U.S. December 2021 greenhouse gas (GHG) standards for light-duty vehicles (LDVs)	8.6
European Union	EU LDV CO ₂ standards that allow the sale of only zero-CO ₂ emission vehicles starting in 2035	5.4
Other markets		2.8
Recent national and subnational policy proposals and announced EV targets <i>(updated Political Momentum scenario compared with the Progress to Date scenario in the 2022 study): 18.9 Gt</i>		
United States	Global MOU on ZE MHDVs commitment, potential ACC II and ACT adoption by more states, ^a and proposed EPA LDV GHG standards	5.1
European Union	European Commission's proposed HDV CO ₂ standards	2.3
ASEAN	Consideration of national EV targets for Indonesia, Malaysia, Singapore, and Thailand.	1.9
Other Asia Pacific <i>(excluding India, China, ASEAN, and Australia)</i>	Consideration of national and subnational EV targets in Nepal, Sri Lanka, and Pakistan and signing of ZEV Declaration by New Zealand.	1.4
Middle East	National EV targets for LDVs and buses in Israel and Turkey signing the ZEV Declaration and Global MOU on ZE MHDVs.	1.2
Mexico	National EV targets and signing of ZEV Declaration by Mexico	1.1
Canada	Federal target of 100% HDV ZEV sales by 2040	1.1
India	Consideration of state level policies and signing of ZEV Declaration by India ^b	1
Latin America <i>(excluding Mexico)</i>	Consideration of national policies in Chile, Colombia, Costa Rica, Ecuador, and Panama. ZEV Declaration was signed by Chile, Dominican Republic, El Salvador, Paraguay, and Uruguay. Global MOU on ZE MHDVs was signed by Aruba, Curacao, Chile, Dominican Republic, Sint Maarten, and Uruguay.	1
Other markets		2.8
Total mitigation achieved by fulfilling international EV commitments (non-binding) <i>(updated Political Momentum scenario compared to Baseline scenario in 2022 study for countries that have signed onto these international commitments): 11.1 Gt^c</i>		
Global	Global MOU on ZE MHDVs ^d	6.3
Global	ZEV Declaration (LDV) ^e	4.8

^a States that have adopted ACC II are California, Vermont, Washington, Oregon, New York, and Massachusetts. States that are expected to consider ACC II regulations based on previous alignment with California are Maryland, Maine, Connecticut, Rhode Island, New Jersey, Maryland, Delaware, Colorado, Minnesota, Nevada, and Virginia. States that have adopted ACT rules are California, Maryland, Massachusetts, New Jersey, New York, Oregon, Washington, and Vermont. Connecticut, North Carolina, and Maine have introduced bills.

^b Includes state level policies from Assam, Chandigarh, Delhi, Goa, Haryana, and Maharashtra

^c This mitigation estimate overlaps with the mitigation potential of national and subnational policies and announced EV targets for countries that have signed these commitments.

^d Signed by 25 countries. Complete list of signatories here: <https://globaldrivetozero.org/mou-nations/>

^e Signed by 41 countries. Complete list of signatories here: <https://acceleratingtozero.org/signatories-views/>

Recently adopted policies and market developments together avoid approximately 17 Gt CO₂ from 2023 to 2050 (Baseline scenario). If governments follow through on their national and subnational policy proposals and EV targets, an additional 25 Gt CO₂ would be avoided through 2050 (Political Momentum scenario). In particular, if countries follow through on their international commitments, our modeling estimates that they would avoid an additional 11 Gt CO₂ compared with the Baseline scenario in the 2022 study. This estimated mitigation potential of international commitments includes region-specific mitigation estimates of the signatories that are included in the first and second sections of Table ES-1.

Figure ES-1 shows projected global well-to-wheel CO₂ emissions from cars, vans, trucks, and buses for each policy scenario. While the figure mirrors the format from the 2022 study, a 1.7°C pathway was added in lieu of the 1.5°C pathway with higher on-road transportation emission share, given the greater stringency in sectoral share.

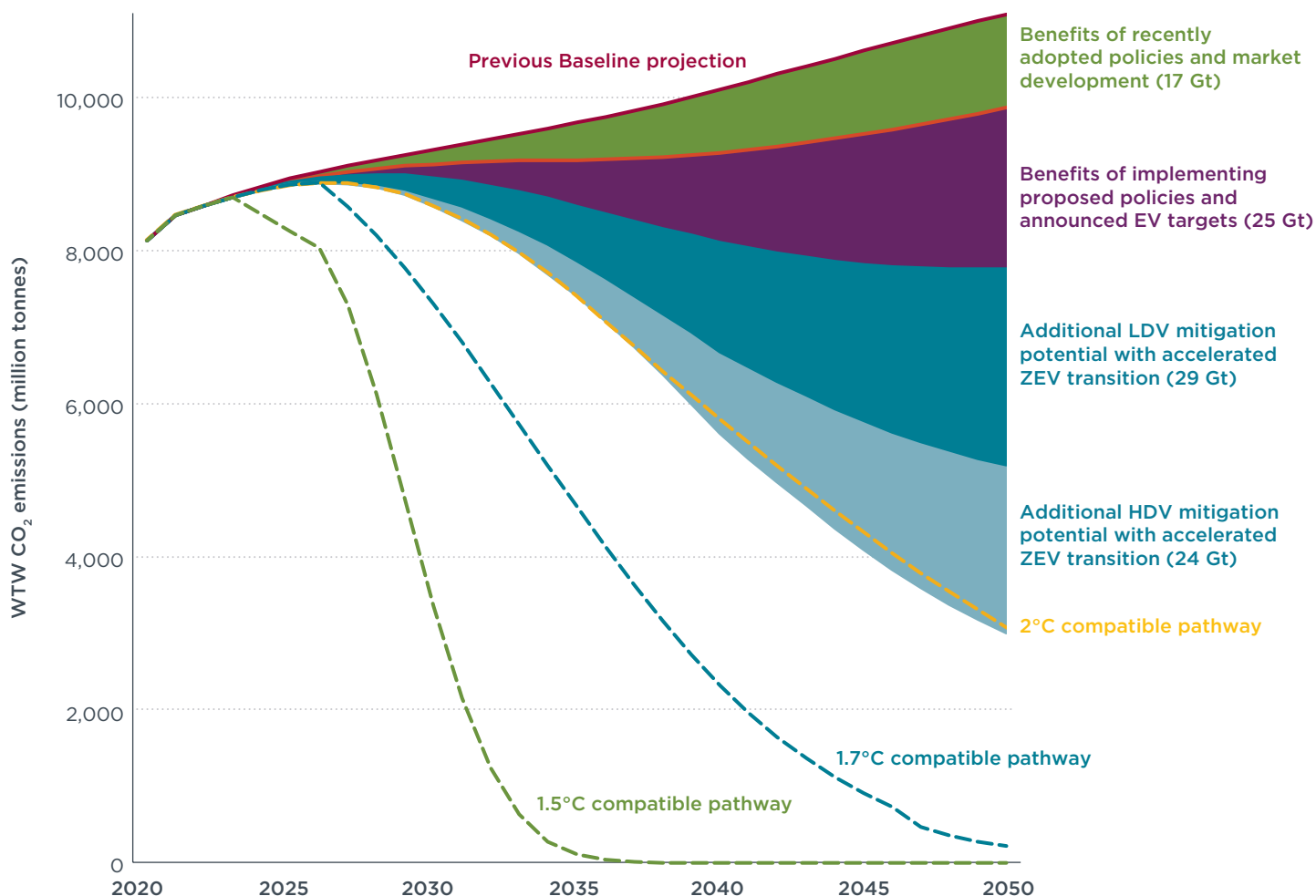


Figure ES-1. Global well-to-wheel (WTW) CO₂ emissions from on-road vehicles compared to emissions pathways compatible with 1.5°C, 1.7°C, and 2°C warming.

Note: The version of the figure from the 2022 study can be found in Sen and Miller (2022; see Figure 3).

As in the previous study, results show that if only adopted policies are considered, global vehicle CO₂ emissions are on a growth trajectory to 2050. However, if governments follow through on proposed policies and announced EV targets, global vehicle CO₂ emissions could peak by 2030 and stabilize near current levels through 2050. Although proposed policies and announced EV targets to date are not sufficient to put global vehicle CO₂ emissions on a below-2°C pathway, governments still have an opportunity to adopt additional policies consistent with the Ambitious ZEV transition scenario.

Based on these findings, we note the following themes:

The ZEV transition covers 72 countries and encompasses all six inhabited continents and 87% of new vehicle sales globally. The additional 17 Gt CO₂ avoided cumulatively through 2050 because of recently adopted policies is primarily driven by federal- and state-level policy developments in the United States and the adoption of more ambitious LDV GHG standards in the European Union and the broader European Economic Area (EEA). The additional 19 Gt CO₂ avoided through 2050 in the Political Momentum scenario compared to the Progress to Date scenario in the 2022 study is

driven by the inclusion of a larger set of countries, regions, and policies. These include the 41 and 25 countries that signed the ZEV Declaration and Global MOU on ZEV MHDVs, respectively; the potential adoption of ACC II and ACT by multiple U.S. states; the proposed EU HDV CO₂ standards; and policy actions by countries including in Southeast Asia, elsewhere in Asia Pacific, and Latin America.

The gap between governments' collective ZEV ambition and a pathway compatible with below 2°C is smaller than it was in the prior analysis. Although the 2022 study identified a total cumulative mitigation potential of 100 Gt CO₂ between the Baseline and Ambitious scenario in the 2020 to 2050 time frame, announced targets were only projected to avoid about 20 Gt CO₂. Based on recently adopted policies, proposals, and announced EV targets, we find that this ambition gap has shrunk by 34%, to 53 Gt CO₂. We estimate that Australia, Canada, European Union, United Kingdom, and the United States can meet close to or over half of their mitigation potential between Baseline and Ambitious by following through on their proposed policy actions. This accounts for 12.6 Gt of the additional cumulative emissions avoided through Political Momentum, or about half of the global total.

A broader set of policy actions—beyond transitioning new vehicle sales to ZEVs—is still needed to limit warming to 1.7°C or 1.5°C. Even if a global ZEV transition were to be achieved in line with our Ambitious ZEV scenario, a further 62 Gt CO₂ would still be need to be avoided by 2050 to limit warming to 1.7°C. The gap is even greater for 1.5°C at 123 Gt CO₂. Further research is needed to assess the additional mitigation potential of actions such as avoid-and-shift policies for passenger and freight travel, improving conventional vehicle fuel efficiency beyond current policy targets, accelerating the removal of older vehicles from the fleet, and adjusting used vehicle import policies to accelerate ZEV uptake. The ICCT, along with partners with expertise in additional mitigation strategies such as the International Energy Agency, International Transport Forum, Institute for Transportation and Development Policy, and United Nations Environment Programme, are currently engaged in research on additional mitigation options that will build on this study.

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INTRODUCTION

Tailpipe emissions from four-wheeled vehicles—cars, vans, buses, and trucks (hereafter, simply “vehicles”)—currently account for about 21% of global anthropogenic carbon dioxide (CO₂) emissions (Sen & Miller, 2022). In order to reduce global emissions to help limit warming to below 2°C or 1.5°C, an accelerated transition to zero-emission vehicles (ZEVs) in the four-wheeled segment is required over the next two decades. Recognizing this, government ministers of several major vehicle markets that represent about half of global vehicle sales and 34% of global ZEV sales established the Zero Emission Vehicles Transition Council (ZEVTC) in November 2020 (U.K. Climate Change Committee, 2021).¹ While tracking the progress of ZEVTC members is an important part of the group’s mandate, the broader mission of the ZEVTC is to accelerate the pace of ZEV transition globally (Joint Statement of the Zero Emission Vehicle Transition Council, 2020).

In 2020, the ICCT published Vision 2050, a strategy to decarbonize the global transportation sector (ICCT, 2020). That strategy found that “electric vehicles are the single-most important technology for decarbonizing the transport sector.” Then, in early 2022, in partnership with ZEVTC, the ICCT published an analysis of the impacts of adopted, proposed, and potential ZEV policy pathways on global vehicle CO₂ emissions through August 2021 (Sen & Miller, 2022). The potential pathway was modeled in the “Ambitious” scenario and the geographic scope included ZEVTC markets and China, as these regions together accounted for three-quarters of global vehicle sales in 2020. It found that the policies announced or proposed by these markets fell considerably short of meeting the potential outlined by the Ambitious scenario, which showed a 73% reduction in CO₂ emissions between 2020 and 2050. Another major finding was that while the Ambitious scenario achieved reductions under the 2°C-compatible pathway, limiting warming to 1.5°C would require much faster reductions than can be delivered by only transitioning new vehicle sales to ZEVs.

This study refreshes the analysis of the 2022 study in a few important ways. Specifically, the data on sales, stock, and activity were updated by considering new data for 2021 and, in some cases, preliminary estimates for 2022; the 2022 study, meanwhile, was based on historical data through 2020. Additionally, historical emissions estimates and activity projections were updated for several markets, including the European Union, United States, India, China, and Australia. The methods of scenario construction and analysis largely are the same as in the 2022 study to allow the results to be directly compared.

This updated study also considers recent ZEV transition announcements and proposals for major vehicle markets through March 2023; the 2022 study considered developments through August 2021. We also expanded the number of regions for which we considered proposed policies and announced electric vehicle (EV) targets. Because of this broader scope, the 2022 “Progress to Date” scenario, which considered developments only in ZEVTC markets and China, is renamed the “Political Momentum” scenario, as it captures the wider global efforts to accelerate the ZEV transition. The “Ambitious” scenario was updated in all markets to ensure that it is at least as stringent as the Political Momentum scenario.

Finally, we altered the construction of the emissions trajectories that are compatible with the Paris Agreement. We added a 1.7°C pathway because the latest Intergovernmental Panel on Climate Change (IPCC) assessment report includes modeling for 1.7°C (IPCC, 2022).

¹ Members of the ZEVTC are the United Kingdom, Canada, Denmark, France, Germany, India, Italy, Japan, Mexico, the Netherlands, Norway, Republic of Korea, Spain, Sweden, and the United States. In addition, the European Commission is an observer and California is separately a member.

METHODS

Historical and projected vehicle CO₂ emissions for each scenario were calculated using ICCT's Roadmap Model (ICCT, 2022). Version 2.2 was used for this study, whereas the previous study used version 1.8.2. Compared to the 2022 study, this study includes:

- » Updated 2021 sales and stock data for all markets and projections are replaced with actual values.
- » Updated historical sales data for the United States and European Economic Area (EEA) in 2019 and 2020 as a result of data quality improvements.
- » Updated historical emissions inventory data for the United States, China, and the European Union through 2021.
- » A comprehensive update of historical data regarding sales, stock, activity, and emission inventories for Australia, Canada, India, and China based on sources used in recent ICCT research.
- » Updated sales projections for all markets based on data updates.
- » Updated stock and activity projections for the United States that closely align data with the Environmental Protection Agency's (EPA's) MOVES3 model (U.S. EPA, 2022).
- » Updated activity projection for the European Union that closely aligns data with the European Union Reference Scenario 2020 (De Vita et al., 2021).

To enable a comparison of the three policy scenarios—Baseline, Political Momentum, and Ambitious—with those in the 2022 study, we remodeled all three scenarios from the 2022 study using updated data and projections and then modeled the three scenarios constructed for this study. The methodology used to construct the Baseline, Political Momentum, and Ambitious scenarios is similar to that of the Baseline, Progress to Date, and Ambitious scenarios of the 2022 study, except for differences in cut-off dates for policy developments and the consideration of more regional and subnational policies in the Political Momentum scenario than were considered in the Progress to Date scenario.

The Baseline scenario follows the same construction methodology of the 2022 study. It accounts for the projected effects of adopted policies and anticipated market developments affecting ZEV sales through 2050; it is not a forecast of the future, but rather a plausible pathway of what could happen in the absence of new policies. The Baseline scenario serves as a reference case to evaluate the benefits of further policy actions in the other scenarios. In the Baseline, adopted policies are modeled based on ICCT's policy analysis in each region and the market potential is based on a combination of ICCT studies, the International Energy Agency's Stated Policies Scenario (STEPS; IEA, 2020), and expert judgment, with the aim of reflecting plausible market growth in the absence of further policies.

The Political Momentum scenario builds on the Baseline by considering announcements, proposals, consultations, and goals from global coalitions, regional entities such as the European Union, individual nations, and subnational entities. The Political Momentum scenario assumes each of the considered policy targets is reached within its stated time period. Thus, this scenario outlines the emission reductions from countries that would result from achieving their targets for ZEV sales and stock, and greenhouse gas (GHG) reductions.

The Ambitious scenario assumes an accelerated global transition to ZEVs in which all countries phase out new internal combustion engine (ICE) vehicle sales no later than 2045. We assumed most of the prominent vehicle markets (the United States, China, the EEA, and Canada) achieve this phase out sooner: by 2035 for light-duty vehicles (LDVs) and 2040 for heavy-duty vehicles (HDVs). The assumption was based on their

market size and current policy ambitions. For a second set of markets (India, Mexico, Japan, and South Korea), we assumed a phase out of sales of new ICE LDVs by 2040 and all ICE vehicles by 2045. For all other countries, we assumed 100% of new vehicle sales are ZEVs by 2045. Countries such as Chile, New Zealand, Singapore, and Ukraine signed a more ambitious international commitment or have a national policy that is more ambitious than a 2045 phaseout; as a result, they are placed on an accelerated timeline consistent with those commitments.

Full details of the assumptions behind the three scenarios are in the 2022 study, and the key differences in scenario construction between the 2022 study and the present study are summarized in Table 1. Most of the differences result from the expanded list of markets considered in this study compared to the 2022 study, where the Baseline and Progress to Date Scenarios only considered proposals and announcements from ZEVTC members and China. Additionally, by updating the cut-off date from August 2021 to March 2023, a large number of new policy developments were considered for ZEVTC members and China.

The new Political Momentum scenario also considers the impact of global agreements such as the Global Memorandum of Understanding on Zero-Emission Medium- And Heavy-Duty Vehicles (Global MOU on ZE MHDVs) and the ZEV Declaration by the Accelerating to Zero Coalition (A2Z Coalition, 2021; Drive to Zero, 2021). The Global MOU on ZE MHDVs is relatively straightforward in the sense that all countries that are signatories have committed to at least a 30% ZEV sales share by 2030 and 100% by 2040. The ZEV Declaration has two categories of national government signatories. It states that the first group “will work towards all sales of new cars and vans being zero emission by 2040 or earlier, or by no later than 2035 in leading markets” and the second group “will work intensely towards accelerated proliferation and adoption of zero-emission vehicles.” The markets in the first group are not specified, nor is the cut-off date for the second group to electrify. For the purposes of modeling, we made the optimistic assumption that all countries in the first group achieve 100% zero-emission new car and van sales by 2035 and all countries in the second group achieve this goal by 2040.

Table 1. Scenario construction differences between the 2022 study and the present study

Parameter	2022 study	This study
Policy cut-off date	August 2021	March 2023
Markets considered for detailed policy modeling	ZEVTC members and China (about 75% of global vehicle sales)	ZEVTC members, China, ASEAN, Other Latin America, Middle East and Africa, Other Asia Pacific (about 87% of global vehicle sales)
Countries with subnational entities considered for detailed policy modeling	United States and Canada (state and province level)	United States, Canada, China, India, and Australia (state and province level)
International ZEV commitments	Not considered	Accelerating to Zero Coalition’s ZEV Declaration, Drive to Zero’s Global MOU on ZE MHDVs
Name of “Announced and proposed policies” scenario	Progress to Date	Political Momentum

KEY POLICY DEVELOPMENTS

The following key policy developments stem from either the expansion of the geographic coverage or the extension of the policy cut-off date in this study. These developments explain most of the differences in emissions between the 2022 study and the results of this paper. Any changes that affect a less ambitious scenario such as Baseline will also affect a more ambitious scenario such as Political Momentum. As such, only significant, marginal changes to each scenario are specified in this list. The policies listed are arranged by scenario and by the nature of scenario construction. Further details on these policies can be found on the ZEVTC website (<https://zevtc.org/>).

ADDED TO BASELINE SCENARIO

- » **Canada:** More stringent EV policies that set goals for Quebec of 100% electrification of government vehicle purchases by 2030 and public bus purchases by 2025, and for British Columbia, an intermediate target of 90% ZEV LDV sales by 2030.
- » **Chile:** LDV GHG standards that require reducing fleet-level emissions 50% by 2030 compared to 2020 for cars and light trucks.
- » **China:** Provincial-level policies for provinces including Beijing, Guangdong, Hainan, and Shanghai. These cover a range of policy ambitions that mainly target public vehicles and new passenger cars; the ambition is for new energy vehicles (NEVs) to be a 45%-100% share of new sales for the former and a 20%-40% share for the latter, both by 2025-2030. NEVs include battery electric vehicles (BEVs), plug-in hybrid electric vehicles, and fuel cell electric vehicles.
- » **European Union:** The LDV CO₂ standards that require 100% sales of zero-CO₂ emission vehicles by 2035. That standards are also applicable to non-EU European Economic Area members.
- » **Mexico:** LDV GHG standards for cars and light trucks that require reducing fleet-level emissions 25%-36% by 2025 compared to 2018.
- » **United States:** For LDVs, aligned with Advanced Clean Cars II (ACC II) regulation and the market potential based on the “IRA Low” scenario from the recent analysis of the Inflation Reduction Act by Energy Innovation and ICCT (Orvis et al., 2022). California’s ACC II phases out all sales of new ICE LDVs by 2035. The federal LDV GHG standards, finalized in December 2021, were also added. For HDVs, California’s Advanced Clean Trucks (ACT) rule, which requires that 40%-75% of sales of new medium and heavy trucks be zero emission by 2035, depending on the segment was also added. Continued ZEV market development at the federal level was assumed to be the average of the regulatory baseline and market potential scenarios from ICCT’s paper on policy options for the Phase III U.S. HDV GHG regulations (Ragon et al., 2023). Because this aligns closely with EPA’s Phase III draft regulations published in April 2023, we did not assume a stricter baseline, even though the market potential is higher considering state-level actions and IRA incentives.
- » **New Zealand:** LDV GHG standards that require fleet-level emissions reduction of 63% for passenger cars and trucks between 2021 and 2027.

ADDED TO POLITICAL MOMENTUM SCENARIO

- » Redefined scenario to include the ZEV Declaration and Global MOU on ZE MHDVs for LDVs and HDVs, respectively, and national and subnational (state and province) targets for emerging markets and developing economies.
- » **ASEAN:** Country-specific policies for Indonesia, Malaysia, Singapore, and Thailand, which are planning to phase out the sale of new LDVs and/or HDVs by 2050.
- » **Australia:** State-level EV targets for New South Wales, Victoria, Queensland, South Australia, and the Australian Capital Territory.
- » **Canada:** Federal phaseout targets for sales of new ICE HDVs by 2040 and the country’s overlapping commitment to the Global MOU on ZE MHDVs.
- » **China:** Targets for new sales of buses, cars, and trucks to include 50% NEVs by 2030 in key polluting regions, as announced by the Ministry of Ecology and Environment.
- » **European Union:** Assumes the EU enacts the HDV GHG standards proposed in February 2023 and assumes the Member States that signed the Global MOU on ZE MHDVs (Austria, Belgium, Croatia, Denmark, Finland, Ireland, Lithuania, Luxembourg, the Netherlands, and Portugal) achieve the zero-emission vehicle targets.

- » **India:** State-level policies from Assam, Chandigarh, Delhi, Goa, Haryana, and Maharashtra that focus on increasing the EV share of new LDV sales between 10% and 50% and the ZEV share of new HDV sales between 25% and 100% by 2030. Also added the country’s commitment to the ZEV Declaration, pursuant to which it plans to phase out new ICE LDV sales by 2040.
- » **Latin America** (excluding Mexico): National policies for Chile, Colombia, Costa Rica, Ecuador, and Panama. Also added ZEV Declaration commitments by Chile, Dominican Republic, El Salvador, Paraguay, and Uruguay, and Global MOU on ZE MHDVs commitments by Aruba, Curacao, Chile, Dominican Republic, Sint Maarten, and Uruguay.
- » **Mexico:** Federal policy with ICE phaseout targets for all new vehicle types and the country’s commitment to the ZEV Declaration, pursuant to which it plans to phase out sales of new ICE LDVs by 2040.
- » **Middle East:** Assumes Turkey and Israel fulfill ZEV Declaration and Global MOU on ZE MHDVs commitments and added national-level policies from Israel that phase out the sale of new ICE buses.
- » **Other Asia Pacific:** Phaseout targets for Nepal, Pakistan, and Sri Lanka, as well as New Zealand’s ZEV Declaration commitment, pursuant to which it plans to phase out the sale of new ICE LDVs by 2035.
- » **United States:** Assumes the Global MOU on ZE MHDVs commitment is fulfilled and the United States reaches 100% ZEV sales by 2040; all Section 177-aligned states adopt ACC II for LDVs; and every state in discussion to adopt ACT for HDVs does so.² Additionally, includes EPA’s proposed GHG standards for LDVs and medium-duty vehicles, which EPA projects will achieve a nationwide BEV sales share of 67% for LDVs and 46% for medium-duty vehicles by 2032.

MODIFIED IN AMBITIOUS SCENARIO

- » Modified the trajectories for all markets to ensure that they remained at least as ambitious as the Political Momentum scenario. In terms of reduction in emissions compared to the 2022 study, the most affected regions in the Ambitious scenario were the United States, the European Union, ASEAN, the Middle East, Latin America excluding Mexico, Australia, and Mexico.

“PARIS-COMPATIBLE” EMISSIONS TRAJECTORIES

The Paris-compatible emissions trajectories were updated to adjust the emissions budget after factoring in 2021 emissions. A 1.7°C pathway was added due to its inclusion in the latest IPCC assessment report (IPCC, 2022). These pathways are shown in Figure 1.

The remaining carbon budgets are based on IPCC’s estimates for a 67% chance of limiting warming to 2°C, and the remaining carbon budget from 2022 onward is around 1,072 gigatonnes (Gt) of CO₂. Assuming vehicle emissions make up a 21% share, as has been the trend in recent years, the remaining budget is around 225 Gt CO₂. We assume that the net-zero date is 2090, and an exponential curve fitting results in a 205 Gt CO₂ budget between 2022 and 2050 (210 Gt budget between 2020 and 2050). Emissions reach very close to net zero by 2080.

² States that have adopted ACC II are California, Vermont, Washington, Oregon, New York, and Massachusetts. States that are expected to consider ACC II regulations based on previous alignment with California are Maryland, Maine, Connecticut, Rhode Island, New Jersey, Maryland, Delaware, Colorado, Minnesota, Nevada, and Virginia. States that have adopted ACT rules are California, Massachusetts, New Jersey, New York, Oregon, Washington, and Vermont. Connecticut, Maryland, North Carolina, and Maine have introduced bills.

For a 67% chance of limiting warming to 1.5°C, the available budget is much smaller, around 67 Gt CO₂ (84 Gt budget between 2020 and 2050). Emissions reach very close to net zero by 2035 and reach net zero by 2040.

For the 1.7°C case, we assumed the 21% share of emissions for vehicles holds. The remaining budget in this case is around 129 Gt (145 Gt budget between 2020 and 2050). Emissions reach very close to net zero by 2055 and reach net zero by 2070.

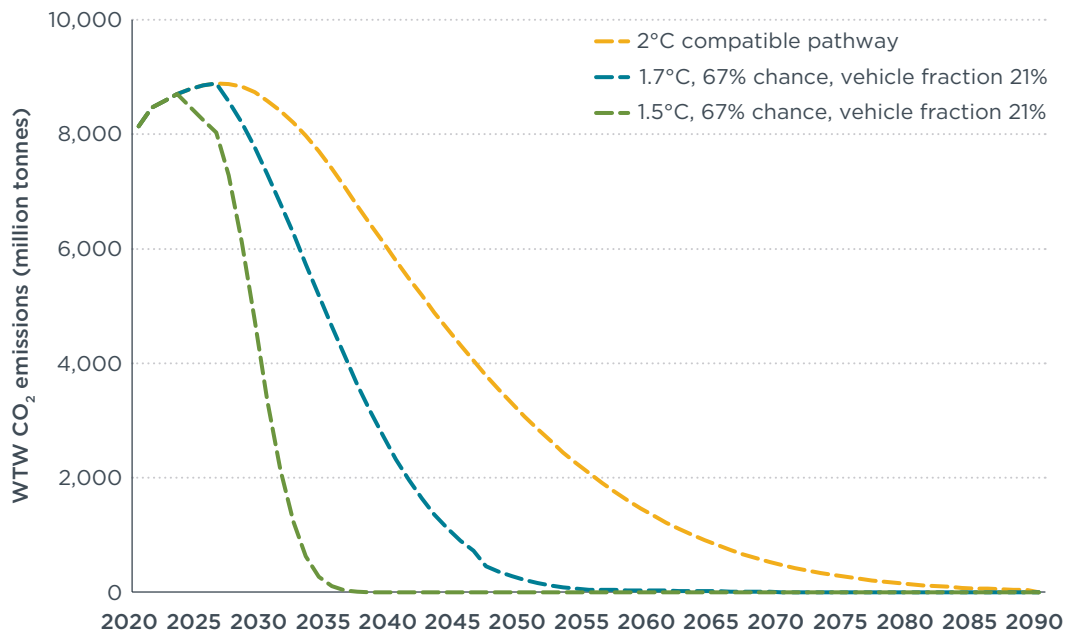


Figure 1. Paris-compatible global well-to-wheel (WTW) CO₂ emission trajectories for light- and heavy-duty vehicles.

RESULTS

HISTORICAL ZEV UPTAKE

The new vehicle sales share for ZEVs, which encompass BEVs and fuel cell electric vehicles, increased for LDVs (cars and vans) in almost all markets in 2022. This was noticeably the case in China (22% for cars in 2022, up from 12% in 2021, and 13% for vans in 2022, up from 11% in 2021), the European Union (12% for cars in 2022, up from 9% in 2021), the United Kingdom (17% for cars in 2022, up from 12% in 2021), and other EEA countries (77% for cars in 2022, up from 61% in 2021). Globally, the ZEV share of new car sales increased from 6% in 2021 to 11% in 2022, and for vans the share increased from 2% to 4%.

The ZEV sales shares of HDVs (buses and trucks) were more modest and adoption occurred mostly in the bus segment. In 2021, the zero-emission share of sales of new medium trucks peaked at around 3% for the European Union and United Kingdom, and for heavy trucks it was less than 1% in all regions (Table 2). For buses in 2021, a more than 10% sales share was seen in China (34%), non-EU EEA countries (26%, mostly from Norway), the United Kingdom (11%) and European Union (slightly more than 10%). The 2022 data for HDV is incomplete and is thus not presented in the table.

Table 2. ZEV share of total new sales by vehicle category and region.

	Car		Van		Bus		Medium truck		Heavy truck	
	2021	2022	2021	2022	2020	2021	2020	2021	2020	2021
Africa	0.3%	0.6%	0.1%	0.8%	0.0%	0.7%	0.0%	0.1%	0.0%	0.1%
ASEAN	0.5%	1.4%	0.3%	0.2%	0.0%	0.5%	0.0%	0.1%	0.0%	0.2%
Australia	0.8%	4.3%	0.4%	0.1%	0.0%	1.5%	0.0%	0.5%	0.0%	0.2%
Brazil	0.2%	0.5%	0.2%	0.2%	0.0%	1.6%	0.0%	0.1%	0.0%	0.2%
Canada	4.0%	5.7%	1.5%	2.9%	1.7%	3.1%	0.0%	0.4%	0.0%	0.2%
China	11.6%	21.7%	11.0%	12.6%	25.6%	33.8%	1.1%	1.9%	0.1%	0.8%
European Union	9.0%	12.5%	3.0%	6.8%	5.9%	10.3%	4.1%	3.3%	0.1%	0.2%
India	0.2%	1.4%	0.0%	0.1%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
Japan	2.2%	1.7%	3.0%	2.0%	0.1%	0.5%	0.0%	0.4%	0.0%	0.1%
Mexico	0.5%	0.7%	0.3%	2.0%	0.0%	1.4%	0.0%	0.2%	0.0%	0.3%
Middle East	1.0%	2.4%	0.2%	0.8%	0.0%	1.2%	0.0%	0.2%	0.0%	0.2%
Non-EU EEA	61.4%	77.2%	16.0%	29.8%	16.4%	26.1%	0.1%	0.8%	0.4%	0.5%
Other Asia Pacific	0.4%	2.8%	0.2%	0.8%	0.0%	0.5%	0.0%	0.1%	0.0%	0.1%
Other Europe	0.1%	7.3%	0.3%	7.3%	0.0%	0.6%	0.0%	0.1%	0.0%	0.2%
Other Latin America	0.2%	0.8%	0.2%	0.8%	0.0%	0.7%	0.0%	0.1%	0.0%	0.4%
Russia	0.0%	0.2%	0.0%	0.8%	0.0%	0.7%	0.0%	0.0%	0.0%	0.4%
South Korea	4.2%	8.8%	2.0%	2.0%	0.0%	0.9%	0.0%	0.6%	0.0%	0.2%
United Kingdom	11.6%	17.1%	0.2%	8.5%	6.2%	10.8%	2.8%	2.8%	0.1%	0.2%
United States	3.2%	5.7%	1.1%	4.0%	0.6%	3.3%	0.0%	0.2%	0.0%	0.2%
Global	6.0%	10.5%	1.9%	3.6%	5.5%	8.9%	0.5%	1.0%	0.1%	0.4%

% of Total Sales: 0.0%  77.2%

Note: Percentage values are rounded to one decimal place. 2022 data is preliminary for LDVs and incomplete for HDVs.

PROJECTED ZEV UPTAKE

In the Baseline scenario, which combines the impact of currently adopted policies and projected market developments, the global ZEV sales share of new cars and vans reaches 41% by 2050 (Table 3). This is higher than the 28% sales share by 2050 in the 2022 study and is driven primarily by the adoption of the EU LDV CO₂ standards and changes in U.S. policies, including the as adoption of ACC II by multiple states and the Inflation Reduction Act (IRA). In the Political Momentum scenario, the ZEV sales share for cars and vans increases to 65% from 49% in the Progress to Date scenario the 2022 study. The Ambitious scenario remains largely similar in terms of ZEV sales share compared to the 2022 study; the global ZEV sales share reaches 89% in 2035, 98% in 2040, and 100% by 2045.

For buses in the Baseline scenario, the ZEV sales share in 2050 is 43%, slightly higher than the 2022 study, which projected a 42% sales share. In the Political Momentum scenario, the projected sales share is 57%, compared to 43% in the 2022 study. In the Ambitious scenario, sales of new buses are assumed to be fully ZEVs by 2040 in all markets.

The truck segment is the slowest to transition in all scenarios. In the Baseline scenario, 18% of new truck sales are ZEVs by 2050, an increase from 13% in the 2022 study. The Political Momentum scenario estimates a 37% ZEV sales share by 2050, compared to 17% in Progress to Date in the 2022 study. This is largely driven by the Global MOU on ZE MHDVs and other large-scale HDV policies that were announced or adopted. Under the Ambitious scenario, 71% of new truck sales are expected to be ZEVs by 2035, 94% by 2040, and 100% by 2045.

Table 3. ZEV new sales share projections for new vehicle sales by scenario and vehicle type.

		2020	2030	2035	2040	2045	2050
Baseline	Cars and vans	2%	24%	34%	36%	38%	41%
	Buses	6%	17%	22%	26%	33%	43%
	Trucks	0%	8%	12%	13%	15%	18%
Momentum	Cars and vans	2%	40%	57%	61%	62%	63%
	Buses	6%	29%	40%	46%	51%	57%
	Trucks	0%	19%	27%	34%	35%	37%
Ambitious	Cars and vans	2%	65%	89%	98%	100%	100%
	Buses	6%	73%	94%	100%	100%	100%
	Trucks	0%	46%	71%	94%	100%	100%

% of Total Sales 0% 100%

ANNUAL VEHICLE CO₂ EMISSIONS

As explained previously, we can compare the annual global vehicle CO₂ emissions pathways between the two studies due to our methodology. The Baseline scenario projects a 17% increase in CO₂ emissions from 2021 to 2050, less than the 31% increase projected in the 2022 study. The most significant difference is observed when comparing the Progress to Date scenario from the 2022 study with the Political Momentum scenario. While the Progress to Date scenario projected a 10% increase in CO₂ emissions from 2021 to 2050, the Political Momentum scenario projects an 8% *reduction* over this period. This means that the national and subregional policy announcements and proposals in major markets, combined with the policy announcements and proposals in emerging markets and global agreements, could stabilize well-to-wheel (WTW) CO₂ emissions between the present day and 2050, with emissions peaking in 2030 (Figure 2).

The Ambitious scenario is largely unchanged compared with the 2022 study, with a 65% emissions reduction from 2021 to 2050 in this study versus 64% in the 2022 study. Although the Political Momentum scenario brings projected global CO₂ emissions closer to the Ambitious pathway than the Progress to Date did in the previous study, the global gap with the Ambitious pathway remains significant.

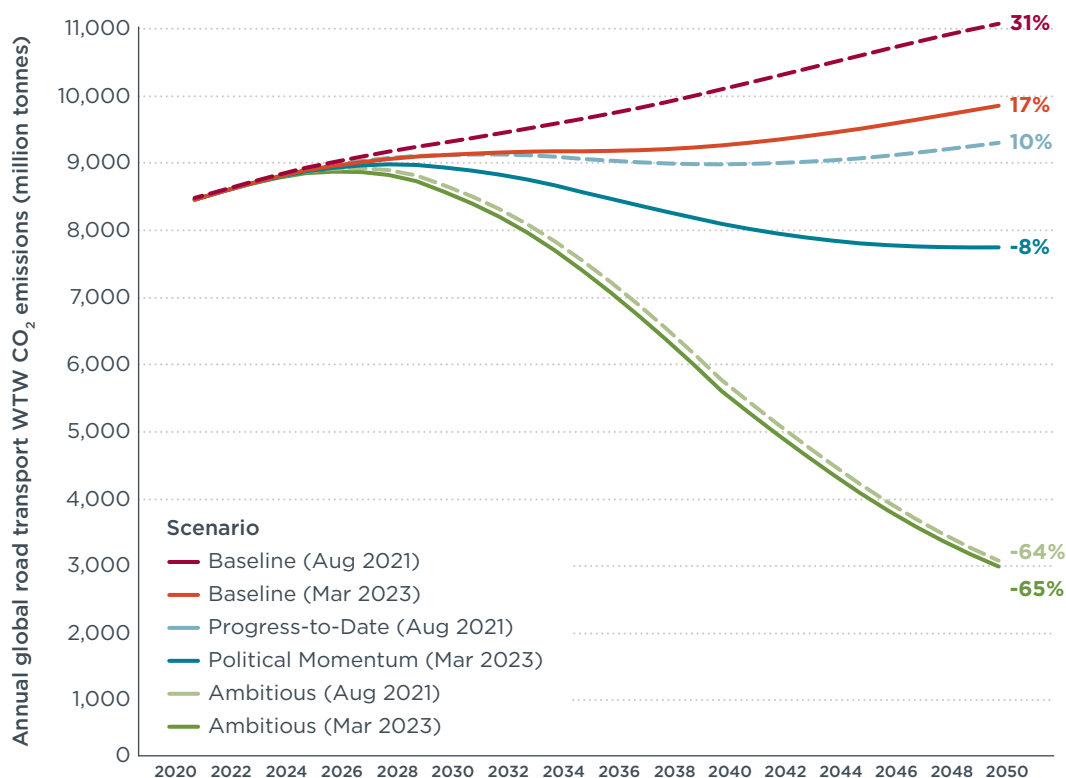


Figure 2. Annual global vehicle CO₂ emissions trajectory, scenarios in the 2022 study (through August 2021), and scenarios in the present study (through March 2023).

CUMULATIVE CO₂ EMISSIONS AND CARBON BUDGET

The updated emissions pathways are contextualized with the Paris-compatible pathways in Figure 3. As shown, this study's Ambitious pathway, which includes the additional LDV and HDV emissions mitigation potential from an accelerated ZEV transition, remains aligned with a 2°C compatible pathway. However, it is still far from the range of 1.5°C and 1.7°C pathways that assume the same 21% share of vehicle emissions as in recent years. A further 62 Gt CO₂ would need to be avoided by 2050 to limit warming to 1.7°C and the gap is even greater for 1.5°C at 123 Gt.

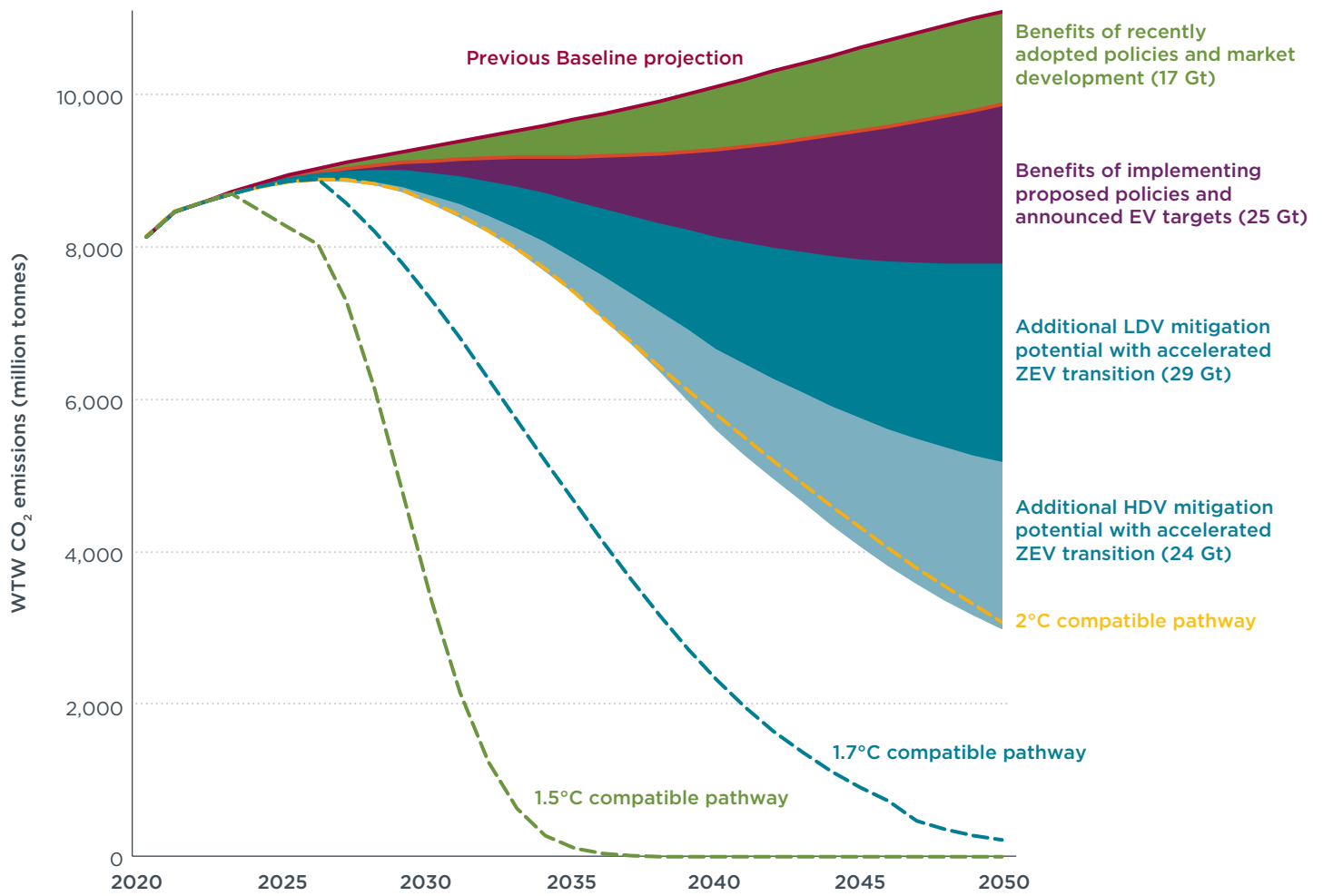


Figure 3. Projected global WTW CO₂ emissions from vehicles compared with emissions pathways compatible with 1.5°C, 1.7°C, and 2°C.

CUMULATIVE CO₂ EMISSIONS MITIGATION POTENTIAL BY REGION

A key long-term impact of transportation decarbonization policies is the reduction in cumulative WTW CO₂ emissions in specific regions. In absolute terms, there are considerable differences in cumulative emissions between the 2022 study and this update, as shown in Figure 4. The updated Baseline scenario projects 16.8 Gt fewer cumulative WTW CO₂ emissions from 2023 to 2050 than the Baseline scenario in the 2022 study. This is the result of a number of policy developments in the United States over the past year and a half, including the adoption of several major state-level policies such as ACC II and ACT, and an improved market outlook resulting from the IRA; it also stems from developments in the European Union, which finalized its revised LDV CO₂ standards.

The Political Momentum scenario projects 18.9 Gt fewer CO₂ emissions than the Progress to Date scenario from the 2022 study. Some of this can be attributed to reductions from the Baseline being carried over, but substantial reductions are also attributable to the United States implementing the targets of the Global MOU on ZE MHDVs, the European Union’s proposed HDV CO₂ standards, India and Mexico increasing ZEV deployment as outlined in the ZEV Declaration, and the national and global commitments of a number of ASEAN, South Asian, Middle Eastern, and Latin American countries that were not modeled in the 2022 study.

In the Ambitious scenario, the CO₂ reductions are only slightly greater, 3.1 Gt less in this current study than in the 2022 study. This is largely because the adjusted targets

in the Political Momentum carry over to the Ambitious scenario and lead to faster ZEV transitions in markets such as United States, European Union, and ASEAN.

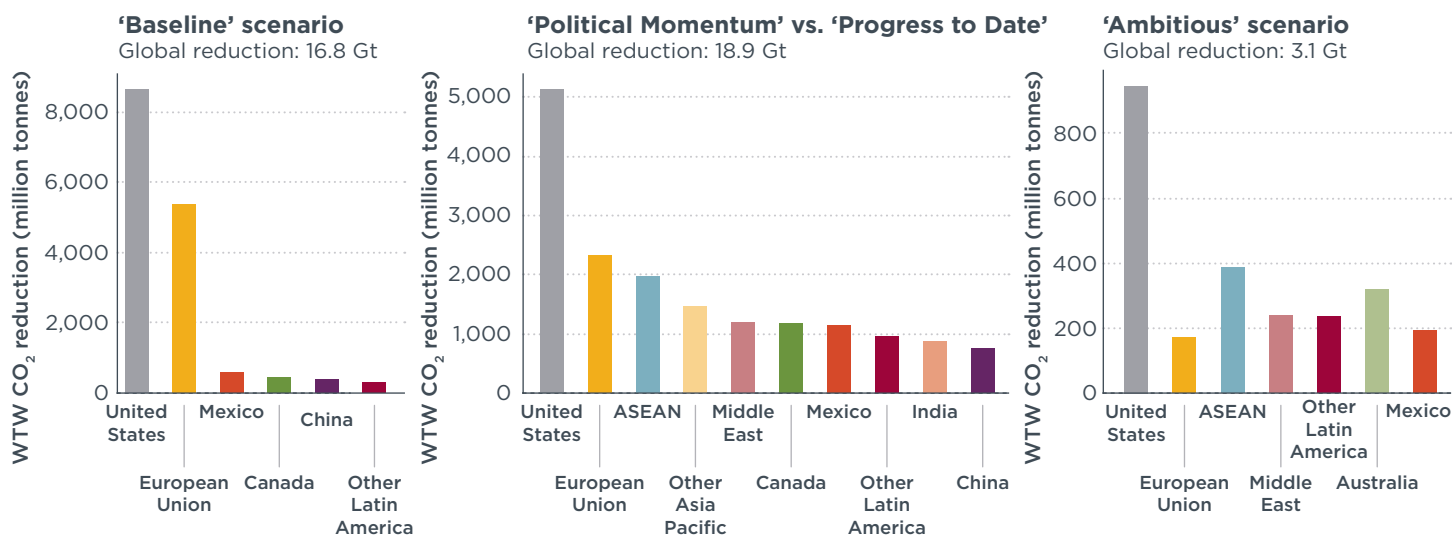


Figure 4. Change in cumulative WTW CO₂ reductions from 2023 to 2050 compared with 2022 study for key regions along with global reduction value.

Table 4 summarizes the policy developments associated with the reductions that are seen in Figure 4. It includes the cumulative impacts of the ZEV Declaration and the Global MOU on ZE MHDVs that encompass a large part of these reductions.

Table 4. Major policy developments between August 2021 and March 2023, including developments that avoid at least around 1 Gt CO₂ cumulatively compared to the scenarios in the 2022 study.

Market	Policy development	Cumulative Gt CO ₂ avoided 2023-2050 compared to the 2022 study
Recently adopted policies and market developments <i>(updated Baseline scenario compared with the Baseline scenario in the 2022 study): 16.8 Gt</i>		
United States	State-level adoption of California's ACC II, ACT, and ACF regulations; projected market growth under IRA; and U.S. December 2021 LDV GHG standards	8.6
European Union	EU LDV CO ₂ standards that allow the sale of only zero-CO ₂ emission vehicles starting in 2035	5.4
Other markets		2.8
Recent national and subnational policy proposals and announced EV targets <i>(updated Political Momentum scenario compared with the Progress to Date scenario in the 2022 study): 18.9 Gt</i>		
United States	Global MOU on ZE MHDVs commitment, potential ACC II and ACT adoption by more states, ^a and proposed EPA LDV GHG standards	5.1
European Union	European Commission's proposed HDV CO ₂ standards	2.3
ASEAN	Consideration of national EV targets for Indonesia, Malaysia, Singapore, and Thailand.	1.9
Other Asia Pacific <i>(excluding India, China, ASEAN, and Australia)</i>	Consideration of national and subnational EV targets in Nepal, Sri Lanka, and Pakistan and signing of ZEV Declaration by New Zealand.	1.4
Middle East	National EV targets for LDVs and buses in Israel and Turkey signing the ZEV Declaration and Global MOU on ZE MHDVs.	1.2
Mexico	National EV targets and signing of the ZEV Declaration by Mexico	1.1
Canada	Federal target of 100% HDV ZEV sales by 2040	1.1
India	Consideration of state level policies and signing of ZEV Declaration by India ^b	1
Latin America <i>(excluding Mexico)</i>	Consideration of national policies in Chile, Colombia, Costa Rica, Ecuador, and Panama. ZEV Declaration was signed by Chile, Dominican Republic, El Salvador, Paraguay, and Uruguay. Global MOU on ZE MHDVs was signed by Aruba, Curacao, Chile, Dominican Republic, Sint Maarten, and Uruguay.	1
Other markets		2.8
Total mitigation achieved by fulfilling international EV commitments (non-binding) <i>(updated Political Momentum scenario compared to Baseline scenario in 2022 study for countries that have signed onto these international commitments): 11.1 Gt^c</i>		
Global	Global MOU on ZE MHDVs ^d	6.3
Global	ZEV Declaration (LDV) ^e	4.8

^a States that have adopted ACC II are California, Vermont, Washington, Oregon, New York, and Massachusetts. States that are expected to consider ACC II regulations based on previous alignment with California are Maryland, Maine, Connecticut, Rhode Island, New Jersey, Maryland, Delaware, Colorado, Minnesota, Nevada, and Virginia.

States that have adopted ACT rules are California, Massachusetts, New Jersey, New York, Oregon, Washington, and Vermont. Connecticut, Maryland, North Carolina, and Maine have introduced bills.

^b Includes state level policies from Assam, Chandigarh, Delhi, Goa, Haryana, Maharashtra

^c This mitigation estimate overlaps with the mitigation potential of national and subnational policies and announced EV targets for countries that have signed these commitments.

^d Signed by 25 countries. Complete list of signatories here: <https://globaldrivetozero.org/mou-nations/>

^e Signed by 41 countries. Complete list of signatories here: <https://acceleratingtozero.org/signatories-views/>

The 2022 study found 100 Gt fewer CO₂ emissions under the Ambitious scenario compared to the Baseline between 2020 and 2050. The Progress to Date scenario avoided 20 Gt of those emissions and left an “ambition gap” of 80 Gt. The updated scenarios in the present study show a smaller gap between governments’ collective ZEV ambition and a pathway compatible with keeping warming below 2°C. Table 5 summarizes the cumulative emissions from 2020 to 2050 for the updated scenarios by region. Based on recently adopted policies, proposals, and announced EV targets, we find that the gap between Baseline and Political Momentum is 24.6 Gt and the

gap between Baseline and Ambitious is 85.3 Gt. This means that the ambition gap has shrunk to 53 Gt CO₂, 34% smaller than in the previous study. We estimate that Australia, Canada, European Union, United Kingdom and the United States can meet close to or over half of their mitigation potential between Baseline and Ambitious by following through on their proposed policy actions. This accounts for 12.6 Gt of the additional cumulative emissions avoided through Political Momentum, or about half of the global potential.

Table 5. Cumulative WTW CO₂ emissions from 2020 to 2050 by region and scenario and difference from the Baseline scenario.

	Baseline	Momentum	Ambitious
Africa	19	19	16
ASEAN	28	26	18
Australia	4	3	3
Brazil	11	11	8
Canada	7	5	5
China	53	50	34
European Union	26	24	21
India	13	12	9
Japan	6	6	4
Mexico	5	4	4
Middle East	26	24	20
Non-EU EEA	0	0	0
Other Asia Pacific	11	9	7
Other Europe	4	3	3
Other Latin America	10	9	7
Russia	6	6	5
South Korea	4	3	2
United Kingdom	4	3	2
United States	49	43	39
Global	285	260	207

Well-to-wheel CO₂ emissions (billion tonnes)



	Momentum	Ambitious
Africa	-0.3	-3
ASEAN	-2	-9.6
Australia	-0.8	-1.2
Brazil	-0.1	-2.7
Canada	-2.1	-2.3
China	-2.9	-18.7
European Union	-2.3	-4.7
India	-1	-4.2
Japan	-0.4	-1.7
Mexico	-1	-1.4
Middle East	-1.3	-6.1
Non-EU EEA	-0.1	-0.1
Other Asia Pacific	-1.5	-4
Other Europe	-0.4	-1
Other Latin America	-0.9	-2.7
Russia	0	-1.1
South Korea	-0.1	-1.3
United Kingdom	-1.4	-1.5
United States	-5.9	-10.1
Global	-24.6	-77.2

Changes in emissions from baseline (billion tonnes)



SUMMARY AND KEY INSIGHTS

This study updated a 2022 ICCT study on the vehicle CO₂ emissions impact of an accelerated global ZEV transition. The present study contains several improvements. It updates historical data through 2021 and 2022; accounts for policy developments in ZEVTC markets from August 2021 to March 2023; adds announced EV targets for emerging markets and developing economies in Asia Pacific, Latin America, the Middle East, and Africa; adds the impacts of global agreements such as the ZEV Declaration and Global MOU on ZE MHDVs; and compares the emissions trajectories of the updated scenarios to the 2022 study and to Paris-compatible emissions pathways. The policy scenarios from the 2022 study were re-modeled with updated data to allow for a consistent comparison.

The Paris-compatible emissions pathways include a 1.5°C pathway and a 1.7°C pathway, both assuming a 21% share for on-road transport emissions in the total carbon budget. Additionally, the ZEV transition scenarios explored are primarily driven by policies that increase the ZEV share of new sales and improve fleetwide vehicle efficiency; other potential policies such as scrappage schemes and avoid-and-shift measures were not considered.

Three main takeaways emerge from this study:

The ZEV transition covers 72 countries across all six inhabited continents and these countries are home to approximately 87% of global vehicle sales. The inclusion of the ZEV Declaration and Global MOU on ZE MHDVs, both signed after the 2022 study's cut-off date of August 2021, added 18 countries to this study that did not previously have a national ZEV sales target for LDVs or HDVs.³

Following through on proposed policies and announced EV targets could stabilize global vehicle CO₂ emissions by 2050, peak emissions by 2030, and shrink the ambition gap with a below-2°C pathway. Compared to the Progress to Date scenario from the 2022 study, our modeling estimates that the Political Momentum scenario would avoid an additional 19 Gt CO₂ cumulatively from 2023 to 2050. The gap between the Ambitious scenario and the Political Momentum scenario is 53 Gt of CO₂, which is less than the 80 Gt gap between Ambitious and Progress to Date in the 2022 study. Australia, Canada, European Union, United Kingdom and the United States can meet close to or over half over half of their mitigation potential between Baseline and Ambitious by following through on their proposed policy actions; this would be 12.6 Gt of the additional cumulative emissions avoided through Political Momentum, or about half of the global potential.

Policy actions beyond accelerating new ZEV sales would be needed to help limit warming to 1.7°C or 1.5°C. Even if a ZEV transition were achieved in line with our Ambitious scenario, a further 62 Gt CO₂ would still need to be avoided by 2050 to align with the best chances of limiting warming to 1.7°C. For 1.5°C, 123 Gt emissions would need to be avoided. There is additional mitigation potential in a variety of other measures, including avoid-and-shift policies for passenger and freight travel, improving conventional vehicle fuel efficiency beyond current policy targets, accelerating the removal of older vehicles from the fleet, and adjusting used vehicle import policies to accelerate ZEV uptake. The ICCT is partnering with the IEA, International Transport Forum, Institute for Transportation and Development Policy, and United Nations Environment Programme to research additional mitigation strategies that will build on this study.

³ Aruba, Curacao, Dominican Republic, New Zealand, Sint Maarten, and Switzerland signed the MOU for MHDVs; Armenia, Azerbaijan, El Salvador, Israel, Ghana, Kenya, Morocco, Paraguay, and Rwanda signed the ZEV Declaration for LDVs; and Turkey, Ukraine, and Uruguay signed both.

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APPENDIX

WTW CO₂ EMISSIONS PROJECTION BY REGION, VEHICLE, AND SCENARIO

Table A1. Projected WTW CO₂ emissions in million tonnes for cars and vans by scenario

	Baseline					Momentum					Ambitious				
	2020	2030	2035	2040	2050	2020	2030	2035	2040	2050	2020	2030	2035	2040	2050
Africa	161	181	207	229	258	161	180	201	214	221	161	174	171	143	62
ASEAN	239	311	370	447	636	239	306	338	365	415	239	299	299	263	151
Australia	82	96	96	93	83	82	89	75	56	26	82	88	72	49	13
Brazil	135	136	146	160	190	135	135	142	154	180	135	129	118	96	47
Canada	138	142	130	117	92	138	134	97	60	19	138	133	94	54	15
China	553	846	863	850	890	553	829	818	772	759	552	769	640	415	116
European Union	651	725	550	357	122	651	725	549	355	119	651	651	449	267	76
India	86	111	121	128	143	86	107	104	86	49	86	100	83	52	21
Japan	152	117	106	97	84	152	115	96	79	59	152	110	76	41	8
Mexico	139	85	75	78	89	139	81	55	36	15	139	81	54	33	10
Middle East	381	399	427	465	535	381	394	409	434	486	381	385	357	292	130
Non-EU EEA	12	9	6	4	2	12	8	5	3	1	12	7	5	2	1
Other Asia Pacific	116	126	153	190	289	116	123	138	149	171	116	122	128	119	78
Other Europe	45	46	48	50	57	45	45	44	42	41	45	44	41	34	19
Other Latin America	146	167	169	168	167	146	165	157	144	128	146	161	137	97	31
Russia	106	95	93	96	99	106	95	93	95	97	106	94	84	69	32
South Korea	65	53	45	40	32	65	53	44	38	31	65	46	29	15	3
United Kingdom	97	80	77	76	77	97	70	49	31	14	97	66	43	25	8
United States	1,271	1,164	972	811	646	1,271	1,131	859	649	457	1,271	1,121	786	441	132
Global	4,575	4,890	4,651	4,458	4,490	4,575	4,783	4,270	3,762	3,288	4,574	4,579	3,666	2,507	954

Table A2. Projected WTW CO₂ emissions in million tonnes for buses by scenario.

	Baseline					Momentum					Ambitious				
	2020	2030	2035	2040	2050	2020	2030	2035	2040	2050	2020	2030	2035	2040	2050
Africa	129	154	204	262	381	129	154	204	262	381	129	153	197	245	352
ASEAN	22	27	32	39	52	22	27	32	39	51	22	25	24	19	8
Australia	2	2	2	2	2	2	2	2	2	2	2	2	1	1	0
Brazil	15	15	16	17	19	15	15	16	17	19	15	14	12	9	4
Canada	4	4	3	3	3	4	3	3	2	0	4	3	2	1	0
China	181	224	213	213	289	181	220	200	188	242	180	197	142	74	42
European Union	25	36	35	34	29	25	32	26	20	13	25	31	23	16	9
India	60	50	51	53	57	60	50	51	53	57	60	46	39	28	16
Japan	10	9	8	9	9	10	9	8	9	9	10	8	7	6	3
Mexico	8	9	10	11	13	8	9	10	11	10	8	8	8	7	7
Middle East	53	56	64	73	87	53	55	61	66	76	53	53	50	44	39
Non-EU EEA	2	1	1	1	1	2	1	1	1	0	2	1	1	0	0
Other Asia Pacific	35	46	66	92	145	35	46	64	83	114	35	44	47	42	26
Other Europe	4	4	4	4	5	4	4	4	4	4	4	4	3	2	1
Other Latin America	45	61	66	68	70	45	58	59	56	53	45	57	52	44	35
Russia	51	58	57	53	41	51	58	57	53	41	51	56	49	36	16
South Korea	20	21	19	17	11	20	20	18	15	10	20	19	13	6	1
United Kingdom	4	3	2	3	3	4	3	2	1	1	4	2	2	1	0
United States	24	29	28	28	27	24	27	24	19	8	24	26	21	15	6
Global	695	806	883	984	1,244	695	793	841	901	1,093	694	751	693	594	566

Table A3. Projected WTW CO₂ emissions in million tonnes for trucks by scenario

	Baseline					Momentum					Ambitious				
	2020	2030	2035	2040	2050	2020	2030	2035	2040	2050	2020	2030	2035	2040	2050
Africa	102	139	167	184	216	102	139	167	184	216	102	138	161	169	171
ASEAN	222	311	390	476	652	222	311	390	476	652	222	302	333	312	163
Australia	27	32	36	40	48	27	32	36	40	48	27	31	31	27	12
Brazil	147	173	181	189	202	147	173	181	189	202	147	169	164	147	95
Canada	85	94	96	100	105	85	90	74	50	20	85	90	72	45	17
China	335	675	715	678	534	335	656	684	640	506	335	614	547	368	96
European Union	246	293	286	283	278	246	277	234	185	112	246	274	226	168	89
India	168	188	201	215	250	168	187	199	211	245	168	183	178	151	101
Japan	72	73	71	71	70	72	73	71	71	70	72	71	60	45	17
Mexico	48	57	62	67	79	48	57	61	63	61	48	56	56	52	41
Middle East	253	243	301	362	481	253	242	293	341	420	253	239	279	301	312
Non-EU EEA	8	8	8	8	8	8	7	6	4	2	8	7	6	4	1
Other Asia Pacific	54	57	69	88	135	54	56	66	79	108	54	55	60	60	42
Other Europe	50	56	62	72	93	50	55	58	61	67	50	55	54	50	30
Other Latin America	78	68	73	85	111	78	67	70	78	95	78	66	64	60	42
Russia	56	48	47	46	44	56	48	47	46	44	56	48	44	38	26
South Korea	37	42	46	53	64	37	41	45	50	62	37	39	35	26	9
United Kingdom	53	43	43.00	44	47	53	40	30	20	10	53	40	30	19	8
United States	572	597	556.00	520	468	572	579	509	403	192	572	578	506	389	184
Global	2,614	3,195	3,409	3,582	3,887	2,614	3,130	3,221	3,193	3,131	2,613	3,053	2,905	2,430	1,456

ZEV NEW SALES SHARE PROJECTIONS BY REGION, VEHICLE, AND SCENARIO

Table A4. Projected ZEV new sales shares for cars and vans by scenario.

	Baseline				Momentum				Ambitious			
	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
Africa	0.0%	3.0%	8.0%	20.0%	0.0%	4.7%	13.2%	24.2%	0.0%	30.0%	90.6%	100.0%
ASEAN	0.0%	3.4%	8.1%	20.0%	0.0%	26.5%	59.1%	72.6%	0.0%	40.5%	92.6%	100.0%
Australia	0.6%	6.0%	12.5%	25.1%	0.6%	33.3%	86.4%	87.3%	0.6%	36.0%	90.9%	100.0%
Brazil	0.0%	3.0%	8.0%	20.0%	0.0%	6.5%	11.8%	23.3%	0.0%	30.0%	90.0%	100.0%
Canada	2.8%	13.3%	24.3%	37.7%	2.8%	72.9%	100.0%	100.0%	2.8%	75.0%	100.0%	100.0%
China	5.2%	29.5%	35.6%	36.5%	5.2%	41.7%	49.5%	49.5%	5.2%	75.0%	100.0%	100.0%
European Union	3.1%	53.8%	100.0%	100.0%	3.1%	53.8%	100.0%	100.0%	3.1%	100.0%	100.0%	100.0%
India	0.2%	8.0%	15.0%	30.0%	0.2%	31.2%	100.0%	100.0%	0.2%	60.0%	100.0%	100.0%
Japan	0.4%	12.0%	15.0%	31.4%	0.4%	27.2%	49.7%	51.8%	0.4%	60.0%	100.0%	100.0%
Mexico	0.1%	8.0%	15.0%	30.0%	0.1%	60.0%	100.0%	100.0%	0.1%	60.0%	100.0%	100.0%
Middle East	0.0%	4.0%	8.4%	20.0%	0.0%	15.7%	27.9%	35.9%	0.0%	36.2%	92.2%	100.0%
Non-EU EEA	31.4%	88.2%	91.3%	91.6%	31.4%	100.0%	100.0%	100.0%	31.4%	100.0%	100.0%	100.0%
Other Asia Pacific	0.2%	3.9%	8.4%	20.1%	0.2%	20.6%	57.2%	61.9%	0.2%	31.7%	91.2%	100.0%
Other Europe	0.0%	12.8%	20.5%	28.4%	0.0%	21.2%	59.3%	66.5%	0.0%	40.0%	96.9%	100.0%
Other Latin America	0.0%	3.0%	8.0%	20.0%	0.0%	8.3%	24.0%	32.7%	0.0%	29.7%	91.4%	100.0%
Russia	0.0%	3.0%	8.0%	20.0%	0.0%	3.0%	8.0%	20.0%	0.0%	30.0%	90.0%	100.0%
South Korea	3.3%	10.3%	15.0%	30.0%	3.3%	29.2%	31.4%	32.9%	3.3%	71.0%	100.0%	100.0%
United Kingdom	4.0%	17.4%	18.2%	30.0%	4.0%	78.7%	100.0%	100.0%	4.0%	100.0%	100.0%	100.0%
United States	1.7%	30.7%	48.5%	48.5%	1.7%	60.5%	67.5%	67.5%	1.7%	65.2%	100.0%	100.0%
Global	2.5%	23.5%	35.8%	41.1%	2.5%	39.9%	60.6%	63.3%	2.5%	65.4%	97.60%	100.00%

Table A5. Projected ZEV new sales shares for buses by scenario.

	Baseline				Momentum				Ambitious			
	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
Africa	0.0%	5.0%	15.0%	40.0%	0.0%	5.0%	15.0%	40.0%	0.0%	60.0%	100.0%	100.0%
ASEAN	0.0%	5.0%	15.0%	40.0%	0.0%	8.1%	20.4%	44.0%	0.0%	60.0%	100.0%	100.0%
Australia	0.0%	5.0%	15.0%	40.0%	0.0%	5.0%	15.0%	40.0%	0.0%	60.0%	100.0%	100.0%
Brazil	0.0%	5.0%	15.0%	40.0%	0.0%	5.0%	15.0%	40.0%	0.0%	60.0%	100.0%	100.0%
Canada	1.7%	10.0%	25.0%	50.0%	1.7%	40.0%	100.0%	100.0%	1.7%	90.0%	100.0%	100.0%
China	25.6%	36.0%	38.1%	42.6%	25.6%	50.0%	55.0%	55.6%	25.6%	90.2%	100.0%	100.0%
European Union	5.9%	18.9%	33.5%	56.2%	5.9%	66.6%	88.0%	89.0%	5.9%	89.6%	100.0%	100.0%
India	0.2%	10.0%	25.0%	50.0%	0.2%	11.7%	25.0%	50.0%	0.2%	75.0%	100.0%	100.0%
Japan	0.1%	10.0%	25.0%	50.0%	0.1%	10.0%	25.0%	50.0%	0.1%	75.0%	100.0%	100.0%
Mexico	0.0%	10.0%	25.0%	50.0%	0.0%	10.0%	47.0%	95.0%	0.0%	75.0%	100.0%	100.0%
Middle East	0.0%	5.0%	15.0%	40.0%	0.0%	12.5%	34.2%	53.3%	0.0%	54.3%	100.0%	100.0%
Non-EU EEA	16.4%	31.7%	37.5%	51.0%	16.4%	72.0%	95.2%	96.2%	16.4%	90.0%	100.0%	100.0%
Other Asia Pacific	0.0%	5.0%	15.0%	40.0%	0.0%	6.7%	52.5%	65.0%	0.0%	60.0%	100.0%	100.0%
Other Europe	0.0%	5.6%	15.9%	40.7%	0.0%	13.3%	29.0%	49.4%	0.0%	58.5%	100.0%	100.0%
Other Latin America	0.0%	5.0%	15.0%	40.0%	0.0%	24.8%	38.3%	53.3%	0.0%	60.0%	100.0%	100.0%
Russia	0.0%	5.0%	15.0%	40.0%	0.0%	5.0%	15.0%	40.0%	0.0%	60.0%	100.0%	100.0%
South Korea	0.0%	10.0%	25.0%	50.0%	0.0%	25.0%	40.0%	50.0%	0.0%	75.0%	100.0%	100.0%
United Kingdom	6.2%	34.6%	40.3%	52.6%	6.2%	51.3%	100.0%	100.0%	6.2%	90.0%	100.0%	100.0%
United States	0.6%	27.8%	39.3%	48.9%	0.6%	49.0%	100.0%	100.0%	0.6%	80.3%	100.0%	100.0%
Global	5.5%	17.3%	26.4%	42.6%	5.5%	28.9%	46.3%	57.0%	5.5%	73.0%	100.0%	100.0%

Table A6. Projected ZEV new sales shares for trucks by scenario.

	Baseline				Momentum				Ambitious			
	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
Africa	0.0%	1.5%	3.5%	7.5%	0.0%	1.5%	3.6%	7.6%	0.0%	25.2%	82.6%	100.0%
ASEAN	0.0%	1.7%	3.6%	8.1%	0.0%	1.7%	3.6%	8.1%	0.0%	26.8%	84.6%	100.0%
Australia	0.0%	1.4%	3.4%	6.9%	0.0%	1.4%	3.4%	6.9%	0.0%	24.1%	80.9%	100.0%
Brazil	0.0%	1.3%	3.3%	6.9%	0.0%	1.3%	3.3%	6.0%	0.0%	22.8%	80.0%	100.0%
Canada	0.0%	4.0%	7.5%	15.2%	0.0%	35.0%	100.0%	100.0%	0.0%	45.1%	100.0%	100.0%
China	0.6%	7.9%	14.6%	24.1%	0.6%	20.6%	23.6%	25.6%	0.6%	65.3%	100.0%	100.0%
European Union	0.4%	7.1%	11.5%	18.7%	0.4%	41.7%	87.6%	88.6%	0.4%	48.4%	100.0%	100.0%
India	0.0%	3.5%	6.2%	12.2%	0.0%	8.9%	9.2%	12.2%	0.0%	32.4%	92.3%	100.0%
Japan	0.0%	4.4%	8.5%	17.1%	0.0%	4.4%	8.5%	17.1%	0.0%	36.9%	97.0%	100.0%
Mexico	0.0%	4.0%	7.7%	15.6%	0.0%	4.5%	38.4%	100.0%	0.0%	35.1%	95.0%	100.0%
Middle East	0.0%	1.5%	3.5%	7.3%	0.0%	7.5%	26.8%	31.6%	0.0%	26.2%	86.7%	100.0%
Non-EU EEA	0.3%	6.9%	11.2%	16.9%	0.3%	48.1%	96.5%	96.9%	0.3%	49.8%	100.0%	100.0%
Other Asia Pacific	0.0%	1.8%	3.7%	8.7%	0.0%	11.8%	38.9%	42.3%	0.0%	27.5%	87.9%	100.0%
Other Europe	0.0%	1.5%	3.4%	6.8%	0.0%	11.6%	38.3%	40.8%	0.0%	26.2%	87.3%	100.0%
Other Latin America	0.0%	1.6%	3.6%	7.7%	0.0%	4.9%	14.5%	18.2%	0.0%	26.4%	85.1%	100.0%
Russia	0.0%	1.5%	3.4%	7.1%	0.0%	1.5%	3.4%	7.1%	0.0%	24.5%	81.6%	100.0%
South Korea	0.0%	4.7%	9.0%	17.6%	0.0%	10.9%	17.6%	18.1%	0.0%	38.4%	97.9%	100.0%
United Kingdom	0.5%	7.0%	11.3%	16.9%	0.5%	55.7%	100.0%	100.0%	0.5%	55.7%	100.0%	100.0%
United States	0.0%	27.2%	39.9%	40.1%	0.0%	40.6%	100.0%	100.0%	0.0%	40.6%	100.0%	100.0%
Global	0.3%	8.0%	13.0%	18.5%	0.3%	18.6%	34.2%	37.2%	0.3%	46.0%	94.20%	100.00%