2024/2025

THE GLOBAL AUTOMAKER RATING 2024/2025

Who is leading the transition to electric vehicles?

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

About the ICCT and this report

The ICCT is an independent, nonprofit organization that provides first-rate, unbiased research and policy analysis on clean transportation to government officials and other relevant stakeholders from civil society and industry. Our mission is to improve the environmental performance and energy efficiency of road, marine, and air transportation to benefit public health and mitigate climate change. The ICCT is the world's leading research organization dedicated solely to clean fuel and vehicle policies and the decarbonization of the transport sector by mid-century.

While the ICCT typically supports government policymakers and regulators as they develop policies to reduce transportation emissions, this report is for a wider audience. We believe the same approach we use to support government regulations—that is, providing timely, high-quality data and analysis to decision-makers—can help inform investors, the broader financial sector, consumers, and auto companies at this critical time in the industry.

This report compares global automakers in the transition to zero-emission vehicles. Our assessment might be of value to investors and rating companies. Consumers may also be interested in knowing how much effort each automaker is making to transition to a fully decarbonized vehicle market and supply chains. And auto companies themselves, all of which have pledged to achieve carbon neutrality, might find our data-driven, transparent assessment of their actions and plans to be a valuable yardstick as they work to find opportunities to improve. We will continue to update this rating and follow our data-driven approach in future years.

Disclaimer

This ICCT report is intended for informational purposes only. Although the ICCT has endeavored to organize and present data from multiple third-party sources in an even-handed and neutral fashion, the selection, interpretation, weighting, and presentation of the metrics in this rating reflect the subjective assessments and opinions of the ICCT. Additionally, while the ICCT has only used data sources it believes to be reliable, taken steps to verify such data with automakers, and identified its sources in the interest of transparency and verification, it cannot state that the data compiled and published by others is accurate. This report should not be construed otherwise.

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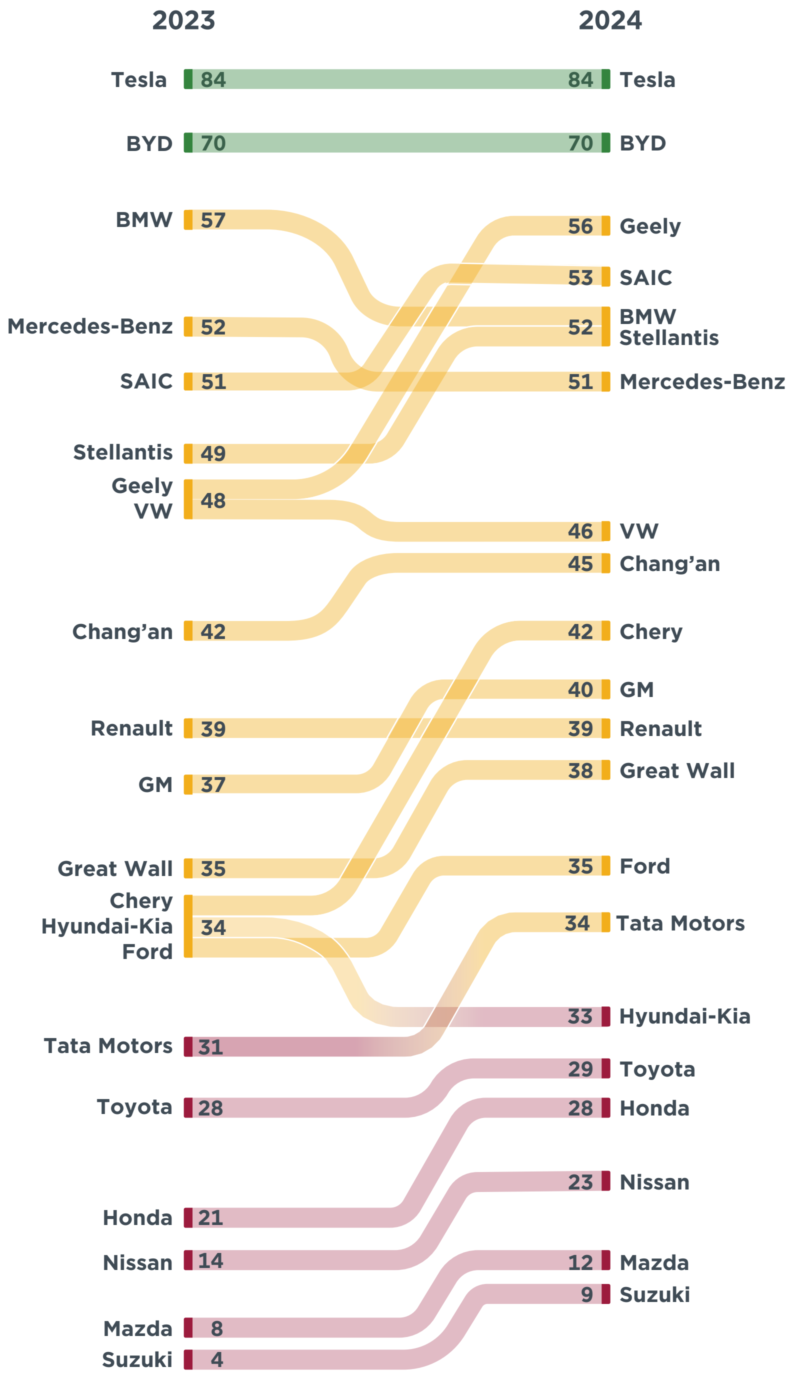
EXECUTIVE SUMMARY

In 2024, electric vehicles (EVs) were nearly 20% of global light-duty vehicle sales—the highest global sales share ever. Absolute sales continue to increase, as well. From 2022 to 2023, there was a 26% increase in global EV sales and from 2023 to 2024, a 27% increase (Fadhil & Shen, 2025). There is remarkable momentum behind electrification. In the coming decade, automakers around the world will compete to rapidly transition to zero-emission vehicles (ZEVs) as electric powertrains become cheaper and more attractive than internal combustion engines.

This third edition of the ICCT's *Global Automaker Rating* report assesses how the world's largest automakers stack up in the transition to ZEVs—that is, battery electric vehicles (BEVs) and fuel-cell electric vehicles (FCEVs). Focused on the top 21 light-duty vehicle manufacturers in the world by sales in 2024, we use 10 custom-built metrics to reflect automakers' efforts and strategies in transitioning their vehicle fleets to zero tailpipe emissions and decarbonizing manufacturing processes. In this year's rating, we introduce a new metric on green steel, update our battery recycling and repurposing metric to consider realized progress rather than just announcements, and update the methodology used to estimate the real-world operation of plug-in hybrid electric vehicles (PHEVs) in China, to reflect the latest research. Nevertheless, the consistency in our evaluation framework enables us to track automakers' progress from 2023 to 2024.

Figure ES1 compares our 2023 ratings (numerical scores) with our 2024 results. The automakers are listed in order from highest to lowest scoring. "Leaders," shown in green, scored in the top third of the rating (66.7–100). "Transitioners," in yellow, scored in the middle third (33.4–66.6). "Laggards," in red, scored in the bottom third (0–33.3).

Figure ES1
Global Automaker Rating, 2023 versus 2024 scores



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Most automakers' scores improved from 2023. The numerical scores of 14 automakers increased, four decreased, and three stayed the same. Key findings of our analysis include:

Tata Motors is the first automaker to transition from "Laggard" to "Transitioner." In 2024, Tata introduced new EV models that diversified its offerings. Tata and subsidiary Jaguar Land Rover also ramped up efforts in battery recycling and repurposing in major markets. Meanwhile, **Hyundai-Kia**, which hovered on the Laggard-Transitioner threshold in the past 2 years, dropped to "Laggard" in this year's rating, partly because it has not disclosed progress on battery recycling and repurposing.

BYD sold more BEVs than co-leader Tesla for the first time in 2024. From 2023 to 2024, BYD continued its expansion in the six major markets studied in this report; its BEV sales increased by 25% and its BEV and PHEV sales combined increased by 47%. Tesla's rating remained the same amid little year-over-year change in its total sales.

Geely and Chery, both in the Transitioners group, showed the most improvement in scores compared with 2023. Geely and Chery increased their ZEV-equivalent sales shares by 13 and 10 percentage points, respectively, while offering new models, and both shifted sales toward high-performing models that improved the average performance of their new BEV fleets. GM, also a Transitioner, similarly introduced new BEV models that raised its average ZEV performance score and greatly contributed to its overall score increase.

Automakers based in Japan and the Republic of Korea still lag, but Honda and Nissan have made progress. Honda introduced its first BEV model, the Prologue, in the United States, and its sales led to substantial improvements in all BEV performance metrics for the company. Nissan strengthened its ZEV ambition by separating its 40% by 2030 ZEV target from a previously announced target that included conventional hybrid vehicles.

Table ES1 presents the full ratings of the 21 manufacturers in 2024 and identifies changes in score from 2023. We group our 10 metrics into three pillars: market dominance, technology performance, and strategic vision. The metrics are weighted equally within each pillar and a simple average of the three pillars is used to generate the overall rating for each manufacturer. For the 2024 overall score and each metric, the number to the left is the final score in 2024 and the arrows and adjacent numbers indicate the score changes from 2023.

Table ES1

Overall scores, Global Automaker Rating 2024

OEM		2024 Overall	MARKET DOMINANCE		TECHNOLOGY PERFORMANCE					STRATEGIC VISION		
			ZEVe sales share	ZEV class coverage	Energy consumption	Charging speed	Driving range	Green Steel	Battery recycle/reuse	ZEV target	ZEV investment	Executive compensation
Tesla	LEADERS	84	100	46	82 ▼	100	100	20	100	100	100	100
BYD		70	75 ▼	76 ▼	65 ▼	25	60 ▼	15	99 ▼	75 ▼	73 ▲	100
Geely	TRANSITIONERS	56 ▲	42 ▲	94 ▲	51 ▲	47 ▲	63 ▲	44	97 ▼	76 ▼	46 ▲	1 ▼
SAIC		53 ▲	47 ▲	100	61 ▲	14 ▲	29 ▲	16	84 ▲	71 ▼	63 ▼	0
BMW		52 ▼	19 ▲	54 ▼	70 ▼	51 ▼	87 ▼	78	84 ▼	68 ▼	18 ▲	52 ▼
Stellantis		52 ▲	8 ▼	70 ▲	33 ▲	29 ▼	38 ▲	25	97 ▼	100	19 ▲	100
Mercedes-Benz		51 ▼	14 ▼	52 ▲	49 ▼	44 ▲	84 ▲	100	91 ▼	89 ▼	42	12 ▼
VW		46 ▼	10 ▼	59	60 ▼	48 ▼	88 ▲	62	78 ▼	79	23 ▲	8
Chang'an		45 ▲	34 ▲	77 ▼	52 ▲	18 ▲	41 ▲	16	50 ▼	94 ▲	36	0
Chery		42 ▲	27 ▲	92 ▲	60 ▲	37 ▲	59 ▲	16	49 ▼	51 ▼	15 ▼	0
GM		40 ▲	6 ▲	17 ▼	75 ▲	51 ▲	94 ▲	53	82 ▲	89 ▲	9 ▼	15 ▼
Renault		39	9 ▼	72 ▼	49 ▲	21 ▲	36 ▲	25	93 ▼	66 ▼	11	17 ▼
Great Wall		38 ▲	26 ▲	47 ▲	39 ▼	25 ▲	49 ▼	16	99 ▼	88 ▼	6 ▲	0
Ford		35 ▲	5 ▲	30	15 ▼	48	85 ▼	72	79 ▼	60 ▼	11	11
Tata Motors		34 ▲	9 ▲	35 ▲	100	5	45 ▲	0	94 ▲	63 ▼	22 ▲	5 ▲
Hyundai-Kia	LAGGARDS	33 ▼	7	28 ▼	40 ▲	76 ▼	73 ▲	23	61 ▼	53 ▼	24 ▲	0
Toyota		29 ▲	2	23 ▼	75 ▲	39 ▲	82	18	68 ▲	48	10 ▲	0
Honda		28 ▲	2 ▲	11 ▲	69 ▲	49 ▲	89 ▲	9	36 ▼	60 ▼	20 ▲	5 ▲
Nissan		23 ▲	4 ▼	29 ▲	16 ▼	24 ▲	37 ▲	27	34 ▲	60 ▲	13 ▲	5
Mazda		12 ▲	2	3	8 ▲	21 ▲	10 ▲	45	0	38	13 ▼	0
Suzuki		9 ▲	0	0	N/A	N/A	N/A	28	0	32	4	0

Note: ▲ indicates score increase compared with 2023; ▼ indicates score decrease compared with 2023.

China-based automakers are ahead in ZEV market dominance. Geely and SAIC reached 50% EV sales shares (including BEV and PHEVs) before our adjustment factors for PHEVs were applied. Both companies thus met their 50% EV by 2025 target 1 year ahead of schedule. Additionally, Geely, SAIC, Chang'an, Chery, and Great Wall all increased their ZEV-equivalent sales shares by 7–13 percentage points from 2023 to 2024, while other automakers made much less progress or even regressed on this metric. The top 5 in ZEV class coverage were all China-based automakers, suggesting that the wider variety of ZEV offerings supports their higher EV sales. Besides Geely and Chery, Tata Motors and Honda were the only two automakers that further diversified their offerings of ZEV models.

There was widespread improvement across automakers in ZEV performance. The majority of automakers scored higher on energy consumption (16 out of 21 improved on this metric), charging speed (16 out of 21), and driving range (17 out of 21). GM and Honda made gains by introducing high-performance BEV models that contributed to the higher scores. Geely, Chang'an, and Chery, which already offered a diverse range of models, improved substantially by introducing new high-performance EV lines or by selling more of their existing high-performance brands.

Automakers that showed more effort in transitioning to renewable energy for manufacturing in our previous ratings received relatively higher scores on the new green steel metric in this rating. These include Mercedes-Benz, BMW, and VW. In addition, Ford and GM performed well on the green steel metric due to better public disclosure of information related to relevant aims and efforts. All five of these automakers have made some commitment to using green steel in manufacturing by 2030, by setting targets and/or securing offtake agreements.

In terms of automakers' strategic vision for ZEVs, 2024 was mixed. Although Nissan made progress by announcing a ZEV-only target and Chang'an and Hyundai-Kia slightly raised their EV targets, Ford, Tata Motors, Dacia (Renault), Mini (BMW), and Volvo Cars (Geely) rolled back or removed their ZEV targets. None of the 21 automakers significantly increased their ZEV investments in 2024. For the first time, Honda linked its executive compensation to a carbon dioxide emissions metric. In contrast, GM removed EV development from the long-term incentives component of its executive compensation plan.

Automakers are increasing transparency about their strategies and supply chains. This year, we received responses from 12 automakers that either validated information used for the analysis or provided additional information. Additionally, Geely linked its executive remuneration incentives to annual carbon reduction goals; this was not disclosed in its previous reporting. Automakers are also sharing more information about their steel supply chains, and that informed the green steel metric in this report.

Lastly, while not part of our rating, **we observe that most automakers need to accelerate ZEV deployment to comply with key regulations.** Only Tesla, BYD, Geely, and SAIC met or exceeded the fleet-average EV sales shares implied by approaching regulations or government EV targets in the major markets. How automakers lobby governments on these regulations is another indication of their commitment to the ZEV transition. While Ford stood out for its vocal support of key policies, Stellantis's public statements on regulations appear out of step with the company's ambitious ZEV target. Toyota's record of lobbying against ZEV policies aligns with its low rating in this report.

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1 INTRODUCTION

The global zero-emission vehicle (ZEV) transition continues to gain momentum, driven by improving technology, declining costs, and widespread adoption of supply-side regulations (Sen et al., 2025). Many major vehicle markets, including the European Union, the United Kingdom, and the United States, have introduced or enhanced regulations to drive accelerated uptake of ZEVs, which include battery electric vehicles (BEVs) and fuel-cell electric vehicles (FCEVs).

In 2024, electric vehicles (EVs) accounted for nearly 20% of total global sales of light-duty vehicles (LDVs; Fadhil & Shen, 2025). Here, LDVs are cars, vans, and pickup trucks, and 20% was the highest global EV sales share ever. The trend for absolute sales continues to increase, as well. From 2022 to 2023, there was a 26% increase in global EV sales and from 2023 to 2024, the increase was 27% (Fadhil & Shen, 2025). Moreover, in the major vehicle markets in 2024, the EV share of new LDV sales reached 44% in China, 20% in Europe, and 10% in the United States (Fadhil & Shen, 2025). Approximately 44% of LDVs sold in the world in 2024 were from automakers that have committed to phase out the production of internal combustion engine vehicles (ICEVs).

The cost of batteries, one of the most important components of EV price, continues to decline (BloombergNEF, 2024), and the purchase price of EVs is expected to fall below that of ICEVs in major markets in the next few years (Slowik et al., 2022). The companies that lead this transition by scaling up ZEV production, advancing technologies, and aligning with evolving regulations will be best positioned to succeed as the market moves toward EVs as the vast majority of new LDV sales.

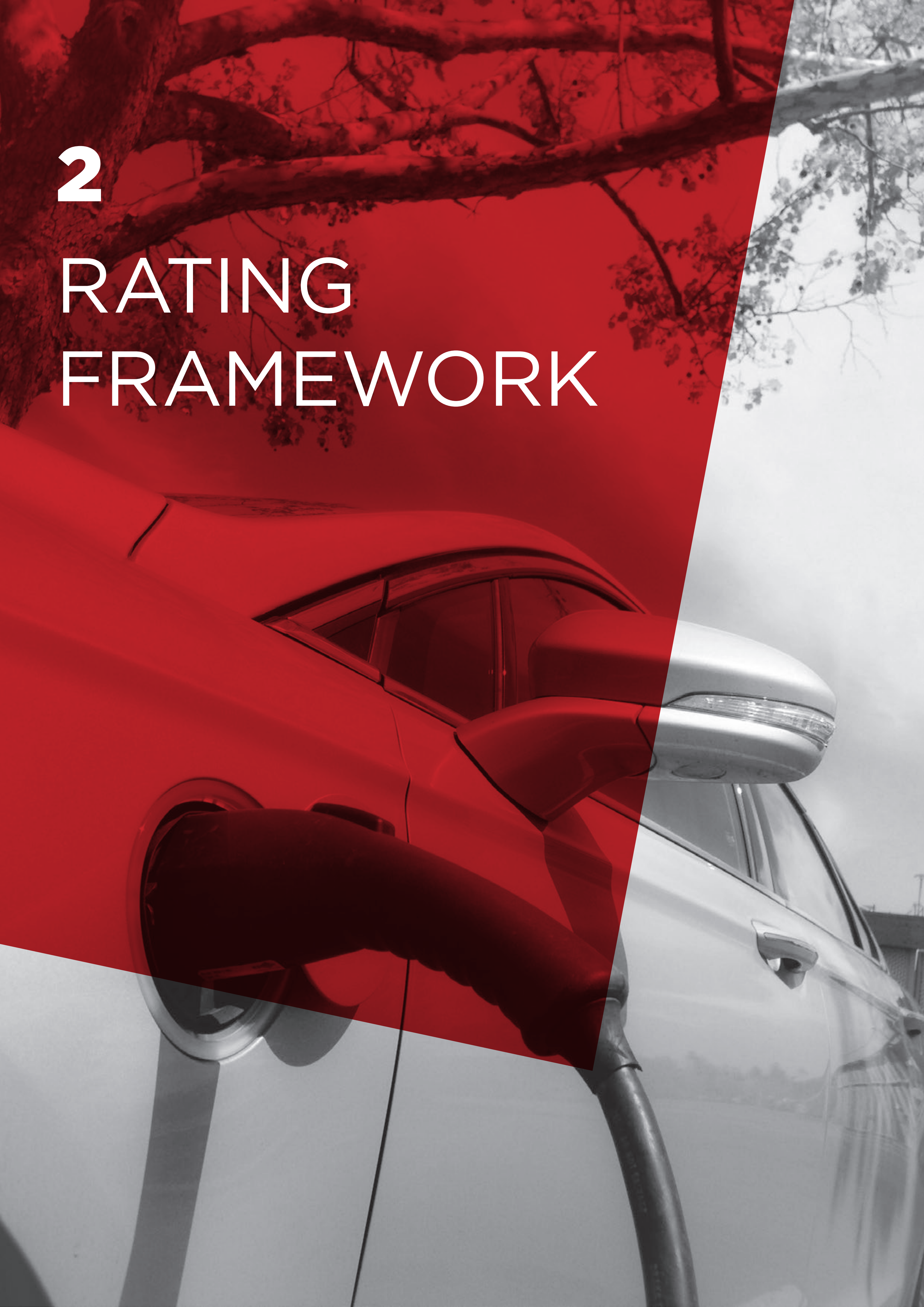
This is the third edition of the ICCT's annual *Global Automaker Rating*, which assesses and tracks the world's top automakers by sales in the context of the global vehicle market's transition to ZEVs. We analyze data and information collected for 2024. To enable year-on-year comparisons, we follow the same evaluation framework established in the previous study and evaluate the same 21 automakers, the largest players in the global vehicle market.

We use 10 custom-built metrics to identify and evaluate efforts by automakers to shift their vehicle fleets to ZEVs and decarbonize their manufacturing operations. We examine each manufacturer's latest ZEV sales and technology, actions to reduce manufacturing emissions, and overall ZEV strategies. For this report, we introduced three updates to the evaluation methodologies. First, we replaced the renewable energy in manufacturing metric with a new green steel metric that reflects current steel supply chains and efforts to procure green steel for future production. Second, we refined the scoring method for battery recycling and repurposing to provide a more granular assessment of manufacturers' progress. Third, we updated the method to estimate the real-world use of PHEVs sold in China to incorporate the latest research. The sections below explain our methodology in detail and identify any changes from the 2023 report. Additionally, we compare the 2024 and 2023 results for each manufacturer to provide insights into industry trends and differences in automaker strategies over time.

As in the previous reports, we exclude vehicles that run on biofuels and e-fuels from our analysis, because previous ICCT research has demonstrated that there is no realistic pathway for using such fuels to decarbonize new ICEVs. Only BEVs and FCEVs using 100% renewable energy are realistic decarbonization pathways, as discussed in Searle et al. (2021).

While there are many published assessments of auto companies, this rating is unique among publicly available reports in its global scope and focus on a transition to a zero-emission future for the industry, rather than on broad environmental, social, and governance (ESG) criteria. Additionally, this rating is based primarily on our own collected data and analysis, rather than on corporate surveys and other self-reported information. We draw on the ICCT's in-depth knowledge of the industry, major markets, and what is required to align with the Paris Agreement.

2 RATING FRAMEWORK



2 RATING FRAMEWORK

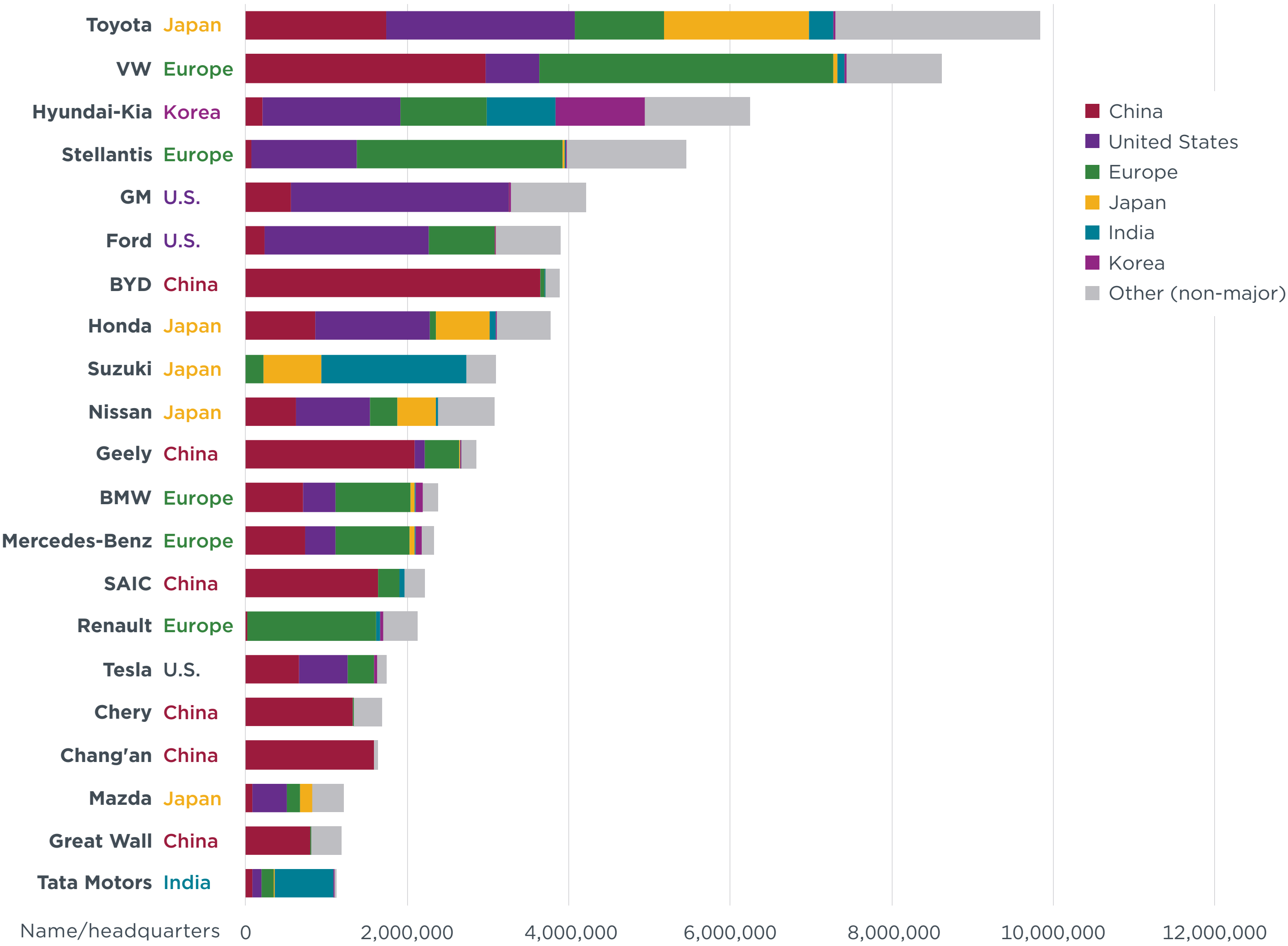
2.1 Scope of the rating

This rating focuses on the production and sale of LDVs, which we define as all cars, pickup trucks, and vans with a gross vehicle weight rating below 3,856 kg in the United States and below 3,500 kg in other markets. This analysis is based on data on automakers in the six largest LDV markets in 2024: China, the United States, Europe, India, and Japan (the top 5 markets in terms of LDV sales in 2024) and the Republic of Korea (the 11th largest in sales and the sixth largest in terms of vehicle production). These six markets have accounted for about 82% of global LDV sales in recent years (MarkLines, n.d.).

We selected the top 21 auto manufacturers in the world based on their 2024 global LDV sales, and that is consistent with the 2023 report. In this report, "manufacturer" and "automaker" mean the controlling corporate entity. An entity might control multiple automotive brands. For joint ventures in China, manufacturers headquartered outside of China collaborate with a China-headquartered counterpart under a technology-sharing agreement; in these cases, we distinguished between vehicles manufactured under non-domestic or domestic brands and then counted the corresponding sales toward the non-domestic or domestic controlling corporate entity accordingly.

Figure 1 shows the 2024 global LDV sales of the top 21 manufacturers, with color coding representing sales in the six markets investigated in this study and an additional category for sales in the rest of the world. These manufacturers accounted for about 90% of all LDV sales in the six markets. The location beside each automaker's name indicates where it is headquartered. Six are headquartered in China, five in Japan, five in Europe, three in the United States, one in the Republic of Korea, and one in India. Most of the 21 manufacturers sell in more than one of the major markets.

Figure 1
Light-duty vehicle sales by the top 21 manufacturers in the six major markets, 2024



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We evaluated manufacturers based on their sales, actions, and strategies in the six markets examined in this study. Vehicle-related analyses were based on new light-duty sales in 2024 and analyses of manufacturer actions and strategies.[1]

2.2 Evaluation structure

We designed the rating around three pillars—market dominance, technology performance, and strategic vision—each made up of particular metrics assessing efforts toward the ZEV transition. As in the previous editions, there are 10 metrics in total, and this year we implemented three changes to our assessment framework.

First, we replaced the renewable energy in manufacturing metric with a green steel metric that evaluates manufacturers' current steel supply chains and efforts to procure green steel in the future. Enabled by recent improvements in data availability and automaker transparency concerning current and planned green steel use, this metric provides a strong signal of automakers' efforts to decarbonize upstream manufacturing

1 Some information was collected in 2025, to verify feedback we received from automakers. Nonetheless, all information reflects the state of the automakers only through 2024.

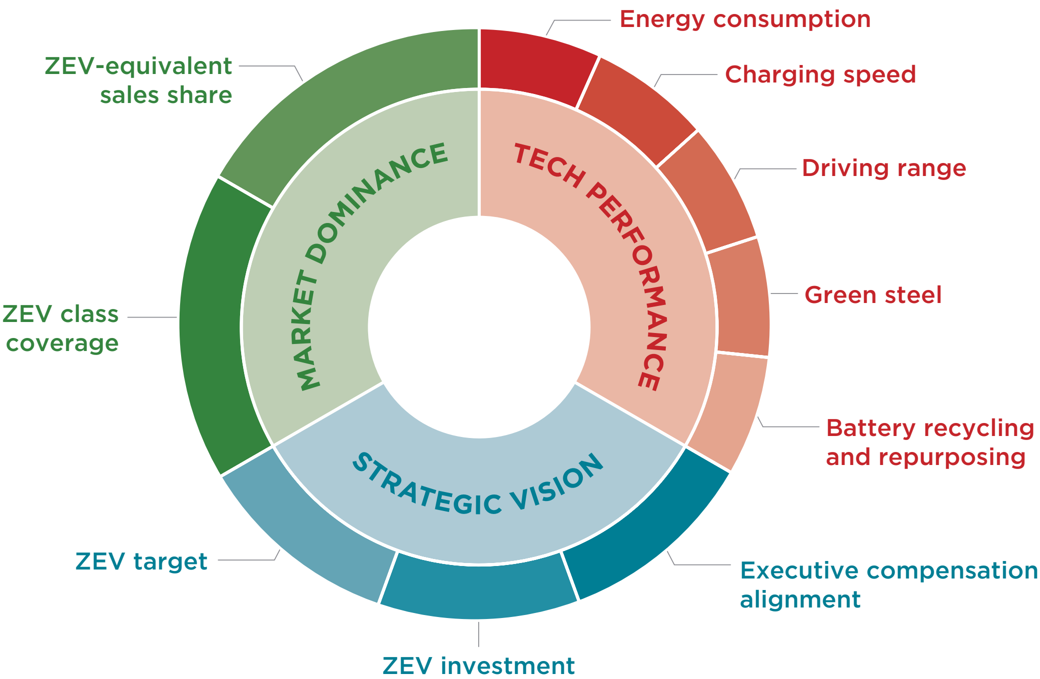
processes because steel production is one of the biggest contributors to vehicle manufacturing emissions, together with battery production and aluminum.

Second, we refined the battery recycling assessment by scoring based on phases of efforts. Manufacturers now receive partial credit for formalized plans and research and development and higher scores for realized operational battery recycling or repurposing projects. This adjustment better reflects manufacturers' progress in building up battery recycling and repurposing capabilities.

Third, we updated the methodology for estimating China's real-world electric drive share of PHEVs by adopting the 2025 utility factor (UF) curve proposed by the China Automotive Technology & Research Center (CATARC, 2025). This better reflects driving behavior in the country.

Figure 2 provides an overview of our *Global Automaker Rating* metrics. The area accorded to each metric in the figure represents its percentage contribution to the final rating.

Figure 2
Structure of the ICCT's *Global Automaker Rating*



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Market dominance reflects the progress each manufacturer has made in its transition to ZEVs. It consists of two metrics:

1. *ZEV-equivalent sales share* is the fraction of each manufacturer's LDV sales that are BEVs, FCEVs, and PHEVs. Each PHEV was adjusted as a percentage of a ZEV using an adjustment factor based on the real-world electric drive share of PHEVs, estimated from recent studies.

2. *ZEV class coverage* reflects the share of eight LDV classes, ranging from mini/subcompact car to light truck, that are covered by model offerings from each manufacturer. To differentiate a manufacturer's ZEV offerings by market, we considered a class to be covered if the manufacturer sold at least 1,000 ZEV units in one market.

Technology performance consists of five metrics, three important to consumer experience and two concerned with reducing upstream emissions, which is an important part of decarbonizing the automotive industry:

- *Energy consumption* is the sales-weighted average of certified energy consumption of BEVs sold by each manufacturer, adjusted by vehicle weight and normalized to the same test cycle in units of watt-hours per kilometer (Wh/km).
- *Charging speed* is the sales-weighted average of charging speed of BEVs sold by a manufacturer, in kilowatts (kW).
- *Driving range* is the sales-weighted average of certified driving range of ZEVs sold by a manufacturer, normalized to the same test cycle and in kilometers (km).
- *Green steel* reflects manufacturers' efforts to procure steel that has lower emissions during production compared with conventional steel production methods, with the goal of eventually sourcing steel that is free of fossil fuels.
- Batt*ery recycling and repurposing* assesses whether manufacturers have planned or implemented battery recycling or reuse projects.

Strategic vision reflects the vision and commitment of each manufacturer in the ZEV transition. It consists of three metrics:

- *ZEV target* is based on each company's stated ZEV sales share targets and dates and their degree of alignment with the ZEV sales shares needed to keep global warming below 2 °C. We evaluated mid-term 2030 targets and long-term 2035 targets if a manufacturer had both, and this allowed us to track progress throughout the transition.
- *ZEV investment* includes total announced investments in ZEV and battery production sites, battery raw materials, charging infrastructure, and ZEV research and development relative to an automaker's size.
- *Executive compensation alignment* reflects the extent to which an automaker's top executive's pay is tied to EV development. A manufacturer is awarded points for linking its executive compensation to parameters associated with EVs and carbon dioxide (CO_2) emissions.

We awarded manufacturers points according to their performance on each metric. The highest possible score in each metric is 100; the lowest is zero. Although, by definition, some metrics have an absolute best and worst performance—as in the case of ZEV sales shares of 100% (best) or 0% (worst)—metrics like energy consumption, charging speed, and driving range have no absolute best or worst. To create an evaluation mechanism that equally applies to all metrics, we used the historical best and worst performers on each metric as benchmarks for scores of 100 and 0, respectively, based on data from current (2024) and previous (2022 and 2023) reporting years. In the event of a methodological change in this report, we recalculated the performance of previous years in that metric based on the revised methodology to determine the historical best and worst performers. Using historical performance as a benchmark enables us to compare automakers within the same reporting year and track their improvement over time.

We applied Equation 1, below, to calculate the final score for each manufacturer for each metric:

$$\textit{Metric score (0 to 100 scale)} = \frac{\textit{Points} - \textit{Points}_{min}}{\textit{Points}_{max} - \textit{Points}_{min}} \times 100 \qquad (1)$$

Where

Points is the number of points for the metric awarded to a given manufacturer;

$\textit{Points}_{min}$ is the lowest number of points awarded for the metric (considering all manufacturers) across reporting years 2022–2024; and

$\textit{Points}_{max}$ is the highest number of points awarded for the metric (considering all manufacturers) across reporting years 2022–2024.

Each pillar score was calculated as the average of the metric scores within that pillar. If any metric was not applicable for a particular manufacturer, we averaged the scores of the other metrics to get the pillar score.[2] Because there are different numbers of metrics within each pillar, the comparative weighting of individual metrics is the same within each pillar, but different from the individual metrics in other pillars. The final rating was calculated as the average of the three pillar scores, which were assigned the same weight because they are equally important. While metric and pillar averages were unrounded, final ratings were rounded to the nearest integer.

2.3 Data sources and process

Five of the metrics assessed in this rating are at the vehicle level and the other five are at the manufacturer level. Vehicle-level metrics are ZEV-equivalent sales share, ZEV class coverage, BEV energy consumption, charging speed, and driving range. Manufacturer-level metrics are green steel, battery recycling, ZEV target, ZEV investment, and executive compensation alignment.

For vehicle-level data, we developed a database that includes all new LDVs sold in 2024 by the manufacturers in the six vehicle markets. We obtained vehicle data from multiple sales databases to maximize data coverage and accuracy. Vehicle sales and powertrain type data for new vehicles sold in 2024 were derived from four sources. Data for the United States, Republic of Korea, and Japan data were from MarkLines (n.d.); Europe data, including vehicle sales in the European Union, European Free Trade Association Member States, and the United Kingdom, were from Dataforce (n.d.); India data were from Segment Y (n.d.); and China data were from Gasgoo (n.d.). For vehicles sold outside of China, data on specifications (length, gross weight and curb weight, gross battery capacity, energy consumption, driving range, charging duration, and PHEV charge-depleting range) were collected from specification brochures on manufacturers' official websites and from major EV information hubs, including EV Database (n.d.), EVSpecifications (n.d.), and EV Volumes (n.d.). Data for models sold in China were collected from Dongchedi (n.d.). Developing a comprehensive set of globally consistent data required substantial processing to reconcile variations in the level of detail among the various datasets. Appendix A describes the methodology used to create this database.

For manufacturer-level data, we used information about the financial value of customer-supplier steel procurement agreements from Bloomberg, and commitments to source green steel in the future were drawn from automakers' announcements and

2 Suzuki received an N/A for the energy consumption, charging speed, and driving range metrics because it did not sell any ZEVs in 2024. It was the only automaker to receive an N/A for any metric.

sustainability reports.[3] Information about battery recycling and repurposing, ZEV targets, ZEV investments, procurement agreements and direct investments in battery raw materials, and charging infrastructure was primarily sourced from manufacturers' latest annual sustainability reports.[4] The reports could come from either the parent company or the subsidiary company, if the latter publishes separate sustainability reports. This information was supplemented with publicly available data from press releases, media articles, and public announcements collected through the end of 2024, to capture any developments between the publication of the sustainability report and the end of the year. Some automakers provided feedback on our input information by referring to sustainability reports published in 2025. We incorporated that information into this rating if it reflected the automaker's efforts in 2024.

Data used to assess manufacturers' investments in ZEVs were obtained from Atlas Public Policy's (n.d.) EV Hub and verified with publicly available information from manufacturers' reports and official announcements. Information regarding the mechanism behind, and elements used in, determining executive compensation was extracted from proxy statements and other public filings of each manufacturer.[5] Detailed information on data sources is presented in the methodology section for each individual metric. Table A1 in Appendix A, includes the complete list of annual sustainability reports and supplementary sources reviewed for this analysis.

Most of the 21 manufacturers operate in multiple major markets, and corporate practices and ambitions can differ across regions. For example, some manufacturers might announce different ZEV targets and ICEV phase-out dates for Europe, the United States, and other regions. To account for such differences, we collected manufacturers' global and regional strategies and implementation actions from the sources described above. Whenever regional practices diverged, we calculated global average performance metrics weighted by vehicle sales in the corresponding regional markets.

To ensure the accuracy and timeliness of the manufacturer-specific information used for this rating, we asked all 21 automakers to review the input data and information used for evaluating manufacturer-specific actions and commitments. We received feedback from 13 automakers: BMW, Ford, Geely, GM, Great Wall, Mercedes-Benz, Nissan, Renault, SAIC, Stellantis, Tata Motors, Tesla, and VW. When automakers disagreed with our information, they generally provided revised or updated data, which were used for the analysis if we were able to verify it.

3 The Bloomberg Supply Chain dataset is a proprietary dataset that contains customer-supplier relationships and quantifies the financial value of transactions between companies. See https://data.bloomberg.com.

4 In some cases, annual sustainability reports were identified by the companies as environmental, climate, or ESG reports. For simplicity, we refer to all of these as "annual sustainability reports" throughout this report.

5 Valens Research, an investment research firm specializing in accounting analytics and corporate valuation and performance, assisted in reviewing information that remains unchanged from last year.

3

MARKET DOMINANCE

3 MARKET DOMINANCE

3.1 ZEV-equivalent sales share

The ZEV-equivalent (ZEVe) sales share, which represents the share of an automaker's total LDV sales that are ZEVs, is the most direct measure of progress in the ZEV transition. The ZEVe sales share is the sum of a manufacturer's ZEV share and the discounted PHEV share. We define ZEVs as BEVs with no additional power source or FCEVs. PHEVs are hybrid vehicles equipped with an internal combustion engine, an electric motor, and a battery that can be recharged with an external electric power source; they are considered partial ZEVs, because they can be driven for a period with zero tailpipe CO_2 emissions. The discount factors for PHEVs in this evaluation are based on real-world statistics.

METHODOLOGY

Vehicle sales data are from the compiled vehicle sales database explained in Section 2.3, which reflects all new LDVs sold in the six major markets in 2024.

While each BEV or FCEV sold counts as one ZEV, we adjusted PHEV sales based on the real-world electric drive share (i.e., the portion of kilometers driven on electricity) to count only the share of their operation that produces zero tailpipe CO_2 emissions. Recent research has estimated that the real-world electric drive share of PHEVs in the United States is 25%–56% lower than indicated in the U.S. Environmental Protection Agency (EPA) labeling program (Isenstadt et al., 2022). Studies have also found real-world electric drive shares in Europe that are lower than official test assumptions (Plötz et al., 2020; Plötz et al., 2022). Incorporating real-world electric drive shares thus can more accurately reflect the climate benefits of PHEVs, which are generally more limited than assumed in type-approval processes.

The real-world electric drive share depends on a vehicle's all-electric range. Data show that, in general, PHEVs with longer electric ranges achieve a higher share of driving in electric mode. We estimated the real-world electric drive share of each PHEV model based on its all-electric range, using equations from the most relevant literature. Details of this calculation are presented in Appendix C.1; the sources of PHEV charge-depleting range data are described in Section 2.3. The sales-weighted average of the real-world electric drive share for all PHEVs sold by the top 21 automakers in the six major markets was 51%.

In this edition, we updated the methodology for estimating China's real-world electric drive share by adopting the proposed 2025 utility factor (UF) curve in Amendment No. 1 to GB/T 19753—2021(CATARC, 2025), which was developed to better capture the real-world driving patterns of PHEVs in China. The proposed 2025 UF curve accounts for common behaviors of drivers in China such as the frequent use of power-priority driving modes, variations in charging habits due to early termination or limited infrastructure, and the longer all-electric ranges of newer PHEV models. By integrating these factors, the 2025 UF curve provides a more realistic estimate of electric drive share, and CATARC validated it through an analysis of 40.6 million km of real-world driving data.

With this update to our methodology, most automakers saw an increase in their estimated real-world electric drive share in China, with notable gains among China-based automakers and others like GM and Honda. On average, the real-world electric drive share of PHEVs in China rose from 48% under the previous methodology to

59% with the revised approach. Details of this comparison are provided in Table C4 in Appendix C.

A manufacturer's ZEVe sales share ranges from 0%–100%. We identified the historical best and worst performers based on data for reporting years 2022–2024. We then assigned a score of 100 to the best performer and a score of zero to the worst performer on this metric. Other manufacturers were scored based on their points relative to the best and worst performers and received a score between zero and 100 (see Equation 1).

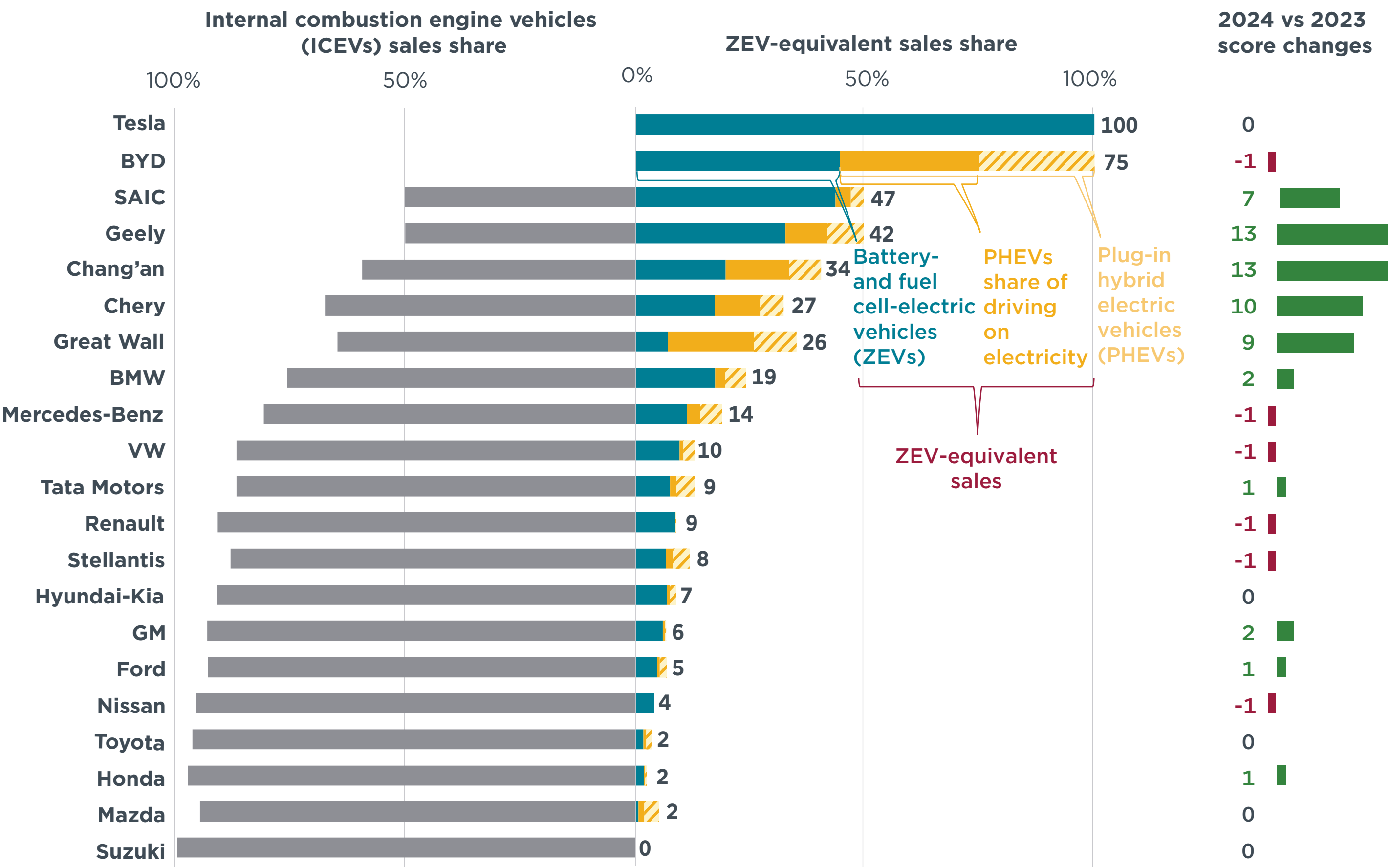
RESULTS

The overall ZEVe sales share of the top automakers in the six markets increased 3.3 percentage points, from 14.6% in 2023 to 17.9% in 2024. There were large variations in manufacturer sales shares. China-based manufacturers made up 6 of the top 7 automakers in this metric, and they had ZEVe sales shares that ranged from 26% to 75%.

Figure 3 summarizes the global ZEVe sales shares of LDVs by manufacturer in 2024 and the score changes compared with 2023. The left section shows the sales share of ICEVs, represented by gray bars. The central section shows the ZEVe sales share, where blue bars reflect the sales share of BEVs and FCEVs and yellow bars represent the PHEV sales share. The solid yellow bars reflect the ZEVe portion of the PHEV sales share based on the electric drive proportion calculated using real world data; the shaded yellow bars, meanwhile, represent the non-electric drive proportion and thus do not count toward the total ZEVe share. The numeric scores for each automaker are presented to the right of each bar. The rightmost section of the figure highlights the year-over-year score changes between 2023 and 2024 for each manufacturer, with green bars indicating an increase and red bars denoting a decrease. Details on ZEV and PHEV sales shares by manufacturer across the six major markets and score comparisons between 2023 and 2024 are presented in Table B1 in Appendix B.

Figure 3

ZEV, PHEV, and ICEV sales shares by manufacturer and ZEVe sales share metric scores, 2024



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Although BEVs continued to comprise the majority of ZEVe sales for most manufacturers, there was an increase in the PHEV share of EV sales, particularly among China-based automakers. For all Chinese manufacturers except Geely, the PHEV share of EV sales increased; BYD, Chang'an, and Great Wall sold more PHEVs than BEVs. Sales of FCEVs were minimal across automakers and made up less than 0.1% of all ZEV sales by the 21 manufacturers; 95% of those sales were by Hyundai-Kia and Toyota, and the remaining sales were split between Stellantis, BMW, SAIC, and Chang'an.

Tesla maintained a 100% ZEVe sales share by only producing BEVs. BYD, which transitioned to 100% EV production in March 2022, ranked second with a 75% ZEVe sales share. All China-based manufacturers except BYD were among the top movers, recording ZEVe sales share increases of 7 to 13 percentage points. SAIC increased to a 47% ZEVe share, enough to rank third behind Tesla and BYD, and Geely, Chang'an, Chery and Great Wall reached 42%, 34%, 27% and 26%, respectively. In contrast, among Europe-headquartered manufacturers, only BMW showed slight improvement—its ZEVe sales share increased by 2 percentage points.

Manufacturers based in the United States and India maintained the same score or made only minor gains (of up to 2 percentage points) compared with 2023. Japan-based manufacturers also saw minimal changes, with year-on-year variations within ±1 percentage point. Suzuki again received a ZEVe score of zero, with no ZEV sales and a PHEV sales share of just 0.02%.

Although this analysis focuses on conventional automakers' progress in the ZEV transition and does not consider absolute increases in EV sales, several manufacturers made substantial progress in growing total EV sales. Chery almost tripled its EV (BEV and PHEV) sales from 2023 to 2024, Honda doubled its EV sales, and BYD and Chang'an increased their ZEV sales by around 50%.

3.2 Class coverage

Automakers often sell a variety of models across many vehicle classes or segments. This is to attract a broad range of customers whose requirements when purchasing a vehicle may vary based on many factors. The class coverage metric evaluates the diversity of BEV and FCEV models offered by manufacturers and how well they cater to different market segments. Manufacturers with broader class coverage have invested in vehicle technology and production platforms to serve different submarkets. We expect this wider range of coverage gives manufacturers an advantage as the ZEV market grows, as it would allow them to access a larger customer base. Selling a variety of ZEV models also supports the overall transition by increasing consumer choice. As this metric reflects manufacturers' efforts toward a zero-tailpipe-emissions future, PHEV models are excluded.

METHODOLOGY

There are no universal definitions of vehicle classes. Consequently, combining data from major vehicle markets results in inconsistent vehicle classifications. To address this, we used a simplified classification system based on vehicle length for passenger cars (PCs) and curb weight for light commercial vehicles (LCVs) and applied it to the ZEV data from all six markets. We classified PCs into five classes: mini/subcompact, compact, midsize, large, and sport utility vehicle/multi-purpose vehicle (SUV/MPV). The length thresholds for PC classification are based on EV Volumes' (n.d.) global segment classification; we combined the mini and subcompact classes to reflect model availability. We categorized LCVs into three classes: small, medium, and large. Curb weight thresholds for LCV classification are based on the EU N1 subclasses standard (Regulation (EC) No 715/2007, 2007) and are detailed in Appendix C.

BEVs typically weigh more than their ICEV counterparts due to the weight of the battery. Because EU curb weight classifications were initially designed for ICEVs, directly mapping BEVs into their corresponding weight classes might lead to inaccurate categorization. For this reason, we adjusted the curb weight of BEVs to be comparable with ICEV equivalents for LCV classification. To determine the appropriate adjustment factor, we selected BEV models in the LCV class that also have a comparable ICEV version. In total, we gathered 14 pairs of such models, as shown in Appendix C.2. The average curb weight ratio between ICEV and BEV versions was found to be 0.83, and that was used to estimate the ICEV-equivalent curb weight of each BEV model. This method proved effective in reasonably estimating ICEV-equivalent curb weights for ZEV models across a wide range of curb weights. We then compared the adjusted curb weight with thresholds from the EU N1 subclasses standard to determine the vehicle class of each LCV BEV model.

The class coverage rate is the ratio of the total number of classes covered by the manufacturer to the total number of classes considered (eight). For instance, if the ZEV models sold by a manufacturer covered four out of the eight classes in one market, we assigned a score of 4/8 (50%) for this market. We considered a class to be covered only if the manufacturer had sold at least 1,000 ZEVs of that class in that market.[6]

6 In the 2023 report, we found that most models with sales under 1,000 in 2022 or 2023 in one market were discontinued between 2019 and 2023. These results suggest that models with sales under 1,000 are unlikely to contribute to an automaker's present or future global market dominance or to the overall ZEV transition.

We evaluated every manufacturer's class coverage in each of the six markets analyzed, then aggregated to the final class coverage, weighted by the manufacturer's LDV sales in each major market. Lastly, we converted the coverage rate to the 100-point system using the historical highest and lowest coverage rate as the benchmark. Other manufacturers were scored based on their relative points on this metric compared with the best and worst performers and received a score between zero and 100 (see Equation 1).

RESULTS

In 2024, while Chery, Geely, and Tata Motors introduced new models that expanded their class coverage, most other manufacturers maintained similar offerings from the previous year and thus received only minor score changes that were driven by market share fluctuations. As in 2023, the SUV/MPV class was the most widely covered, with all ZEV-producing manufacturers offering models in this class. Table 1 summarizes class coverage across all six major markets and the final scores for this metric. To the right, we also show the 2023 rating.

Table 1
ZEV (BEV and FCEV) model class coverage for each manufacturer

OEM	Class coverage by region						2024 sales-weighted average	2024 score	2023 score
	China	United States	Europe	India	Japan	Korea			
SAIC	88%	0%	50%	25%	0%	0%	81%	100	100
Geely	88%	25%	38%	0%	0%	0%	76%	94	78
Chery	75%	0%	12%	0%	0%	0%	74%	92	78
Chang'an	62%	0%	0%	0%	0%	0%	62%	77	93
BYD	62%	0%	38%	12%	12%	0%	62%	76	77
Renault	25%	0%	62%	0%	0%	0%	58%	72	74
Stellantis	25%	0%	88%	12%	0%	0%	57%	70	68
VW	38%	25%	62%	0%	12%	25%	48%	59	59
BMW	38%	50%	50%	0%	0%	38%	44%	54	55
Mercedes-Benz	25%	38%	62%	0%	12%	25%	42%	52	50
Great Wall	38%	0%	12%	0%	0%	0%	38%	47	46
Tesla	25%	50%	38%	0%	25%	25%	37%	46	46
Tata Motors	0%	12%	12%	38%	0%	0%	28%	35	23
Ford	12%	25%	25%	0%	0%	0%	24%	30	30
Nissan	12%	25%	38%	0%	25%	0%	23%	29	28
Hyundai-Kia	12%	25%	25%	0%	0%	38%	23%	28	30
Toyota	25%	12%	38%	0%	12%	0%	18%	23	28
GM	25%	12%	0%	0%	0%	0%	14%	17	19
Honda	12%	12%	12%	0%	0%	0%	9%	11	6
Mazda	0%	0%	12%	0%	0%	0%	3%	3	3
Suzuki	0%	0%	0%	0%	0%	0%	0%	0	0

China-based manufacturers outperformed others in class coverage and occupied the top 5 positions. SAIC led with a sales-weighted class coverage of 81% and received a score of 100. Geely (score of 94) and Chery (92) were close behind, thanks to the introduction of new models in 2024. For example, Geely subsidiary Yuancheng introduced new models in the large LCV class and Chery subsidiary Kaiyi launched the

Xuandu in the medium PC class. India-based manufacturer Tata Motors also stood out with a 12-point increase in coverage linked to its launch of the Ace Mini Truck, which added coverage in the small LCV class.

Though Chang'an, BYD, and Great Wall had no change in class coverage, Chang'an's score declined due to a change in how LCVs are categorized. In this assessment, to align more closely with the EU N1 subclass standard, we adjusted the basis for classification from curb weight to reference mass (curb weight plus 100 kg). This change reclassified a portion of Chang'an's small LCV class into the medium LCV class. Great Wall was the only China-headquartered manufacturer to score under 50, and it ranked below the Europe-based manufacturers.

Europe-, Japan-, and U.S.-based manufacturers experienced only minor changes in class coverage scores, and this was due to market share fluctuations within existing classes rather than the introduction of new models. Europe-based manufacturers performed above average, occupying positions 5–10 in the ranking. Japan- and U.S.-based manufacturers, meanwhile, continued to lag behind. Suzuki received a score of zero because it offered only plug-in hybrid SUVs and no ZEV models in any class.

As in our previous evaluation, there were factors that this metric did not capture equally across all automakers. For instance, Tesla's offerings were in a limited range of classes, but it sold exclusively BEVs. Other manufacturers had multiple ZEV models at a variety of price points, but within only a few classes. While these manufacturers might thus be better positioned to sell within those classes today, their customer base may be more limited. Additionally, the popularity of PCs and LCVs varies across the six major markets, and some automakers might offer models in certain classes because of the popularity of those classes in a certain market. Still, this analysis is global in scope; most of the automakers assessed operate globally. Therefore, the more classes an automaker covers, the more they contribute to the global ZEV transition across all vehicle classes.

4

TECHNOLOGY PERFORMANCE

4 TECHNOLOGY PERFORMANCE

4.1 Energy consumption

The energy consumption metric evaluates the sales-weighted average certified energy consumption of BEVs sold by each manufacturer. Energy consumption measures the amount of energy consumed per distance traveled. For vehicles with the same battery size, the more efficient vehicle can drive longer distances per charge. BEVs that consume less energy consume less electricity and have lower upstream emissions from vehicle use. Vehicles that consume less energy also reduce energy costs for operators. Additionally, with lower energy consumption, the same range can be achieved with a smaller battery, and that can lower vehicle cost.

METHODOLOGY

We computed the energy consumption of each BEV model in our database by dividing the net (usable) battery capacity by the certified driving range, expressed in Wh/km. The resulting energy consumption values were usually lower than the rated energy consumption reported to regulatory agencies, which accounts for charging losses. However, because rated energy consumption data were not equally available across markets, we used the calculated energy consumption values for comparison. For models for which no data on net battery capacity were available, a multiplier of 0.95 was applied to the gross battery capacity, which was estimated from regression analysis using 228 models with both net and gross battery capacity information available. The regression analysis used an ordinary least squares (OLS) model to regress the net battery capacity on gross battery capacity.

FCEVs were excluded from the calculation of fleet-average energy consumption. In addition to accounting for a much smaller market share than BEVs, FCEVs operate differently. BEVs use electricity stored in batteries; although there are some losses (e.g., from charging, battery management, and drivetrain), the energy path is relatively direct and results in a charging socket-to-wheel efficiency of around 75%–85%. On the other hand, FCEVs store hydrogen in tanks. During operation, a fuel cell converts the hydrogen into electricity to power an electric motor, and substantial energy is lost during this process. In addition, drivetrain losses further reduce overall efficiency, and this all results in a tank-to-wheel efficiency of only around 50% (Heid et al., 2021).

Energy consumption data were calculated from certified driving range values measured using different test cycles, including the Worldwide harmonized Light vehicles Test Procedure (WLTP), New European Driving Cycle (NEDC), China Light-Duty Vehicle Test Cycle (CLTC), and the U.S. label value used by EPA. Energy consumption values from the different test cycles were standardized to WLTP-equivalent values by using conversion factors. Based on Yoney (2022), we applied a multiplier of 1.15 to convert the NEDC or CLTC energy consumption to its equivalent value under the WLTP test cycle, and U.S. label values were divided by 1.2 to derive WLTP-equivalent values. These conversions allowed for a consistent comparison of energy consumption across models.

We adjusted the energy consumption of each BEV model to account for the weight differences of vehicles, as physical differences inherently affect energy consumption. Indeed, regressing energy consumption on curb weight using all BEV models in our database showed a high statistical correlation between the two variables (see Appendix C.3). This adjustment allowed manufacturers to be compared regardless of differences in the size of the vehicles they sell. For example, all BEVs sold by Ford were SUVs or LCVs with an average curb weight of 2,311 kg, while more than 62% of BEVs sold by SAIC were subcompact or compact cars that had an average curb weight of 1,185 kg.

For the weight adjustment, we benchmarked the energy consumption of each model to the same baseline weight of 1,743 kg, which is the sales-weighted average curb weight of all new ZEVs sold by the top 21 automakers in 2024 in the six markets. A regression analysis of the 2024 fleet showed that, on average, each 1 kg increase in curb weight was correlated with a 0.0514 Wh/km increase in energy consumption. This means that for a model that is 100 kg heavier than the baseline of 1,743 kg, we would adjust the energy consumption downward by 5.14 Wh/km (100*0.0514) to normalize the energy consumption. For models lighter than the baseline, the energy consumption was adjusted upward. These parameters were largely consistent with the adjustment factors used in the 2023 report, which were based on the 2023 fleet.[7] To account for the updated adjustment factors, we recalculated the adjusted energy consumption for the 2023 fleet using both sets of parameters (Appendix C.3).

With the adjusted energy consumption of each model, we calculated the sales-weighted average energy consumption for each manufacturer. The adjusted energy consumption values were then converted to a 100-point score using the historical highest and lowest fleet-average energy consumption as the benchmark. After comparing the 2023 and 2024 values, we assigned a score of 100 to the historical best performer with the lowest sales-weighted average energy consumption and a score of zero to the historical worst performer with the highest sales-weighted average energy consumption. Other manufacturers were scored based on their relative metric points compared with the historical best and worst performers and received a score between zero and 100 (see Equation 1).

We acknowledge the difference between real-world and reported values, which may vary in degree across brands (Komnos et al., 2022; Jin et al., 2023; Al-Wreikat et al., 2021; Kothari, 2023). However, there are no ideal real-world data sources that cover the wide range of models and brands in this analysis. In the absence of a high-quality real-world database, we used certified values from vehicle type-approval processes. This also reflects the information given to consumers in the official specifications of a manufacturer's offerings. If sufficient real-world data on energy consumption become available in future years, we will aim to incorporate them into our assessment for this metric.

RESULTS

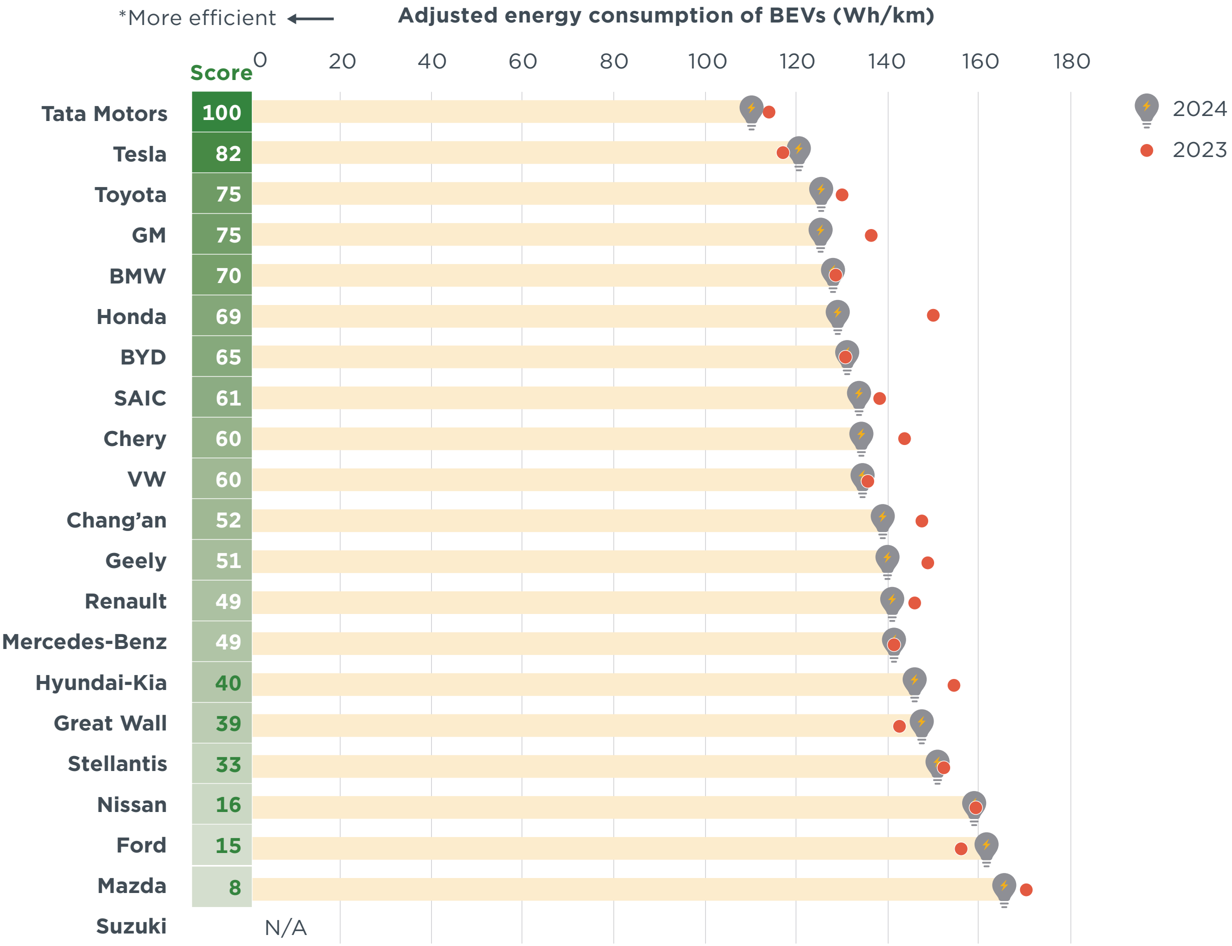
In 2024, the majority of manufacturers (16 out of 21) showed improvements in energy consumption after adjustment. On average, the adjusted energy consumption of BEVs among the top automakers continued to decline, decreasing from 135 Wh/km in 2023 to 132 Wh/km in 2024. There are still noticeable differences in BEV energy consumption among automakers. The energy consumption of the lowest-scoring automaker, Mazda, is about 67% higher than that of the highest-scoring automaker, Tata Motors.

Figure 4 illustrates the average energy consumption of BEVs after the adjustment by vehicle curb weight and presents the score for this metric by manufacturer. Shorter bars illustrate lower average energy consumption, which translates into a higher metric score. Red dots show the corresponding 2023 value of this metric for each manufacturer. As noted above, the adjusted energy consumption for 2023 was recalculated using 2024 regression parameters to ensure a consistent comparison. Data on the average energy consumption of BEVs before and after the adjustment by weight are presented in Appendix B, Table B2. The table shows original and adjusted energy consumption for both the 2023 and 2024 fleets and compares scores between the two reporting years.

7 That analysis used a baseline weight of 1,743 kg and a similar correlation of 0.0516 Wh/km.

Figure 4

Average energy consumption of BEVs and metric scores by manufacturer



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Tata Motors continued to lead on this metric, with adjusted energy consumption of 110 Wh/km. Compared with 2023, 16 automakers demonstrated improvements in fleet-average energy consumption, while three experienced minor declines in performance (all within an increase of 5 Wh/km) due to changes in fleet composition.

One key factor driving improvements was an increase in the popularity of more efficient models. For instance, the sales share of the relatively efficient bZ3 (with an adjusted energy consumption of 108 Wh/km) among all of Toyota's BEVs increased from 26% in 2023 to 36% in 2024. In addition, some manufacturers improved their efficiency by expanding their BEV portfolios with new, more efficient models, and that led to more notable gains. Honda, for example, saw the most substantial improvement due to the introduction of new BEV models in 2024. While it previously only offered the e-series, sold mainly in China, Honda introduced the Prologue, a relatively efficient model (adjusted energy consumption of 128 Wh/km) and it quickly rose to 58% of its BEV sales in major markets. Similarly, after Chery introduced the iCAR series in 2023, the sales share of the relatively efficient iCAR 03 (adjusted energy consumption of 124 Wh/km) among all Chery BEVs increased to 19% in 2024 during its first year of official release.

4.2 Charging speed

Concerns about the length of charging time, especially during long-distance travel, can significantly impact consumer BEV purchase decisions (Li et al., 2020). Although some direct current (DC) fast chargers can deliver up to 350 kW, the average charging rates that vehicles can accept vary widely. For example, the Citroën Ami from Stellantis supports only alternating current (AC) charging and is equipped with a relatively low-capacity 3.6 kW onboard charger that requires approximately 4 hours to fully charge the 5.5 kWh battery. In contrast, the Hyundai IONIQ 5 features an 11 kW onboard AC charger and also supports 350 kW DC fast charging; using DC fast charging, it can charge its 72.6 kWh battery from 10% to 80% in just 18 minutes, an average charging rate of 169 kW.

METHODOLOGY

For this metric, we calculated the sales-weighted average charging speed (in kW) of BEV models sold by each manufacturer. Similar to energy consumption, we excluded FCEVs. To calculate the charging speed for each BEV model, information on net battery capacity and charging duration of all compatible chargers was collected and compiled into a ZEV specification database (see Section 2.3). As with energy consumption, for models for which no data on net battery capacity were available, a multiplier of 0.95 was applied to the gross battery capacity.

Data on the charging speed of BEV models are typically provided by automakers for normal and fast chargers. Normal chargers refer to Level 2 home, workplace, and public chargers with typical power ratings between 3 kW and 22 kW from AC (Rajon Bernard et al., 2021). Fast chargers are DC with power ratings between 50 kW and 350 kW. In this analysis, charger type definitions follow the European Court of Auditors (2021); for details, see Appendix C.4. All BEV models accept normal chargers, but only some BEV models are capable of DC fast charging. The maximum charging speed possible with DC fast chargers varies by vehicle model.

For BEV normal charging, each model's average charging speed was calculated by dividing its net battery capacity by the amount of time needed to charge from 0% to 100%. For BEV fast charging, the average charging speed for most models was based on 70% of the net battery capacity and the time needed to charge the battery from 10% to 80%, which is the value manufacturers typically provide for fast charging.[8] This range is also representative of the real-world use of fast chargers, as most drivers fast charge to a state of charge between 20% and 80%, and because charging speed typically slows down significantly above 80%, as the battery management system slows the charging rate to avoid overcharging and to prolong battery life (Whaling, 2022). Therefore, we defined the average charging speed for fast charging as the net battery capacity in kWh multiplied by the charged percentages of 70% divided by the time (in hours).

Since 2023, there has been an increase in the number of BEV models capable of battery swapping offered by China-based manufacturers; these include the Maple 60S and 80V from Geely and the Rising Auto R7 and F7 from SAIC. Nonetheless, swap-capable BEVs still represented a small BEV sales share (less than 2%) for those manufacturers and were primarily designed for taxi services (OFweek, 2023). All electric vehicles capable of battery swapping also offer non-swapping charging options. For this study, we only assessed the non-swapping charging speed of these vehicles. The focus of this metric is on conventional charging methods, to better track

8 Some manufacturers report charging time needed to charge from 30% to 80%; in these cases,we used 50% of the net battery capacity.

and reflect automakers' progress in improving technology performance; we regard swapping as a form of mode innovation with significant uncertainty rather than a technology improvement, and it is thus not a focus of this report.

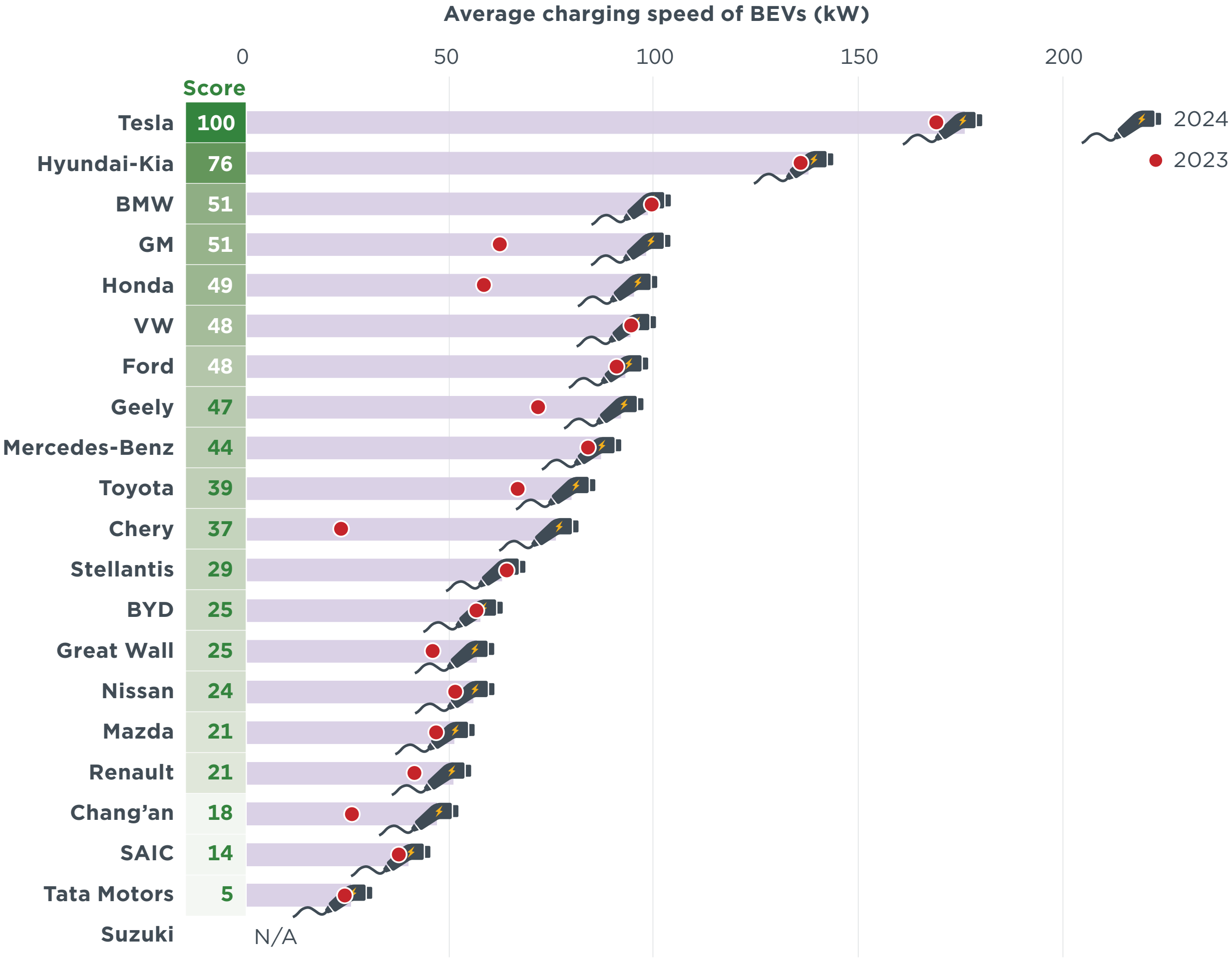
If a model had multiple charging options, we selected the charging speed from the fastest option it allowed. Then we averaged the maximum average charging speed of all BEV models of each manufacturer weighted by the sales of the models. Average charging speed values were converted to a 100-point score following Equation 1. The historical best performer of all reporting years, with the fastest charging speed, received a score of 100, and the historical worst performer with the slowest charging speed received a score of zero. Other manufacturers were scored based on their relative speed compared with the historical best and worst performers and received a score between zero and 100.

RESULTS

In 2024, the majority of manufacturers (16 out of 21) showed improvements in charging speed. The sales-weighted average charging speed of BEVs among all 21 automakers increased from 90 kW in 2023 to 93 kW in 2024. Automakers showed significant variations in sales-weighted average charging speed, with the highest-scoring automaker charging six times faster, on average, than the lowest-scoring automaker. Chery, Honda, GM, and Chang'an made notable improvements by introducing new models with faster charging speeds, improving their average charging speed by 20 kW compared with 2023.

Figure 5 shows the average charging speed and final score for each manufacturer. Red dots show the corresponding 2023 value on this metric for each automaker. Table B3 in Appendix B details the sales-weighted average charging speeds for BEVs that do and do not support fast charging, and the sales share of each BEV type for each manufacturer. The table also shows the score comparison between 2023 and 2024.

Figure 5
Average charging speed and metric score by manufacturer



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Chery experienced the most substantial increase, with its average charging speed rising from 24 kW in 2023 to 76 kW in 2024. Its ranking improved from the lowest among major BEV manufacturers in 2023 to 11th place in 2024. In 2023, Chery's top-selling model was the Chery QQ Ice Cream, which accounted for 48% of its BEV sales and took 75 minutes to charge its 17 kWh battery to 80%. By 2024, the QQ's sales share dropped to 18% and the best-selling model became the iCAR 03, which can charge its 70 kWh battery from 30% to 80% in 30 minutes; this significantly improved Chery's overall charging speed.

Honda, GM, and Chang'an also made gains by introducing models with fast charging capabilities, including the Honda Prologue and GM Blazer. For Chang'an, the improvement was also due to a shift in sales toward premium models. In 2024, the sales share of Deepal, Chang'an's premium brand, increased to 23%, from 7% in 2023. Deepal offers some of the automaker's fastest-charging models, including the Deepal S05 and S07, and this boosted Chang'an's overall charging speed.

SAIC and Tata Motors, while still recording relatively slower average charging speeds, showed some improvement. SAIC's speed was partly because 34% of its BEV sales were models that do not support fast charging (though this is down from 41% in 2023). For Tata Motors, even though more than 91% of its BEVs sold in 2024 support fast charging, the average charging speed remained much lower than that of the leading manufacturers. For example, the Tata Punch, which became its best-selling BEV model in 2024 with a 32% market share, requires 56 minutes to charge its 35 kWh battery from 10% to 80%; that resulted in an average charging speed of approximately 23 kW.

Tesla and Hyundai-Kia maintained the top two positions in charging speed without further improvement, with average charging speeds of 176 kW and 138 kW, respectively. Both companies had several high-selling models among the fastest-charging BEVs available, including the Tesla Model Y, Hyundai IONIQ 5, and Kia EV6.

4.3 Driving range

Driving range is another metric valued by consumers, as longer range expands vehicle functionality and minimizes range anxiety. It is a key factor in the convenience of BEVs for consumers. Automakers that only offer shorter-range BEVs might struggle to keep up in the ZEV transition; research suggests consumers might be less likely to switch to EVs with short ranges (Stockkamp et al., 2021). In another indication of the importance of driving range, the California Air Resources Board (CARB) has set minimum range requirements for BEVs that can count toward the ZEV targets in its Advanced Clean Cars II regulation. Offering higher-range vehicles could encourage faster ZEV uptake and deliver more climate benefits while making automakers more competitive.

Although consumers generally prefer a longer driving range, this comes with costs, both financial and environmental. According to Poupinha and Dornoff (2024), larger battery packs can increase energy consumption and total cost of ownership and contribute to higher greenhouse gas (GHG) emissions than BEVs with smaller battery packs. There are costs for the manufacturer as well, as larger batteries require greater quantities of input materials such as lithium and other critical minerals. Designing BEVs with longer ranges can thus increase manufacturer exposure to price swings in lithium and other minerals compared with making short-range vehicles. Additionally, because battery production and mining are major sources of the overall GHG emissions resulting from BEV manufacturing, making longer-range vehicles will increase those emissions as long as fossil fuels are used in upstream mining and manufacturing.

Despite such considerations, we include this metric in our assessment because of the importance of driving range in attracting a wide consumer base. Additionally, as the vehicle market is still dominated by ICEVs, larger-battery BEVs still provide environmental benefits relative to conventional-fuel counterparts.

METHODOLOGY

The sales-weighted average driving range of ZEVs sold by each manufacturer was calculated after excluding models that sold fewer than 100 units in total across the six major markets. We first collected certified driving ranges in kilometers for each ZEV model in our vehicle database. This specification measures the maximum distance that a BEV can travel on a full charge without recharging, or that an FCEV can travel on a single tank of hydrogen without refueling.

Like energy consumption, the driving range of BEV models in the database was measured using different test cycles. We followed the same method to standardize the range values of different test cycles to WLTP-equivalent driving range using conversion factors. We applied a discount factor of 1.15 for NEDC and CLTC ranges and a multiplier of 1.2 for U.S. label values to yield the equivalent value under the WLTP test cycle (Yoney, 2022).

The data were then weighted based on the total sales of each model in the six major markets in 2024, and that resulted in a weighted average that reflected the typical driving range under laboratory testing. The average driving range of each manufacturer was then converted to a 100-point score following Equation 1. The historical best performer, with the longest sales-weighted average range, received a score of 100, and the historical worst performer, with the shortest average range, received a score of zero. Other manufacturers were scored based on their relative driving range compared with the historical best and worst performers and received a score between zero and 100.

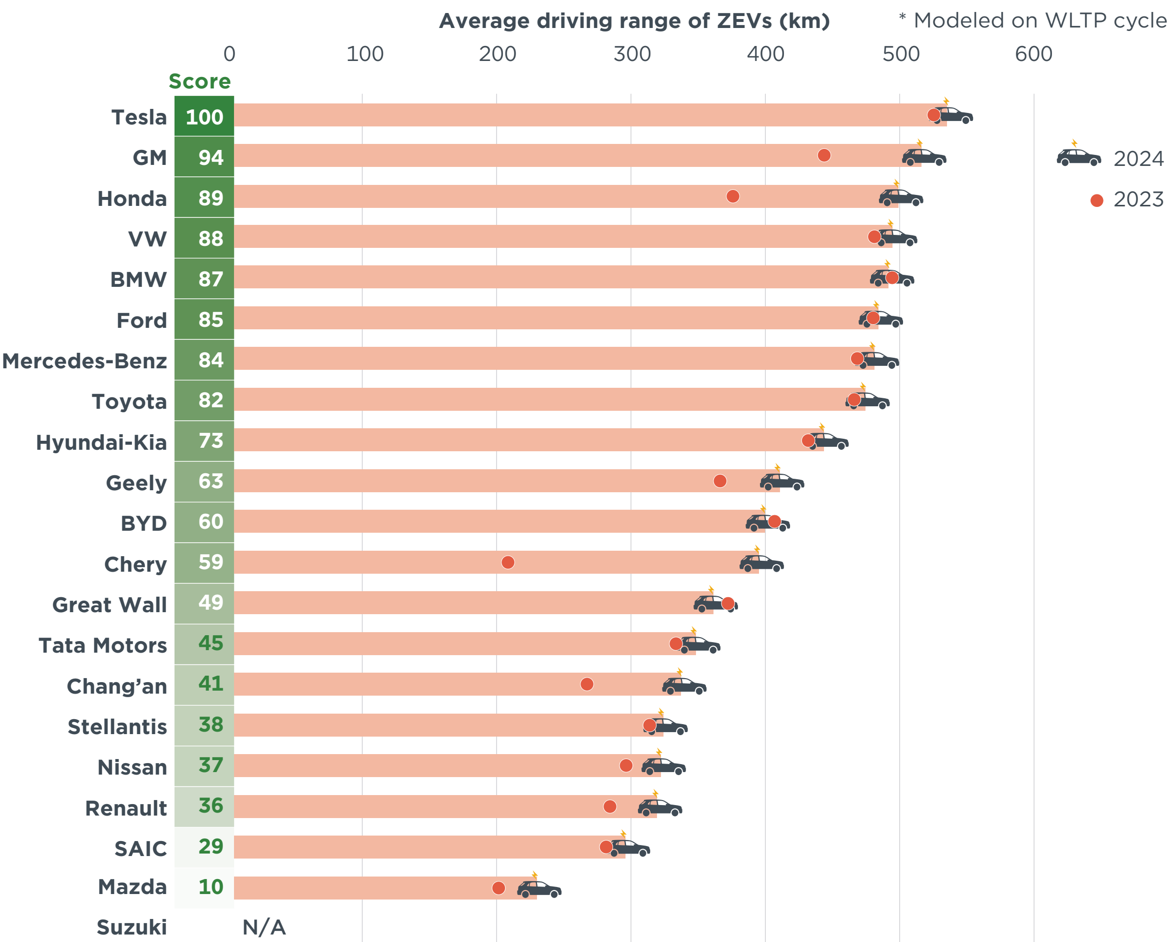
There is some overlap between the energy consumption and the driving range metric, because the efficiency of a vehicle is a key determinant of its driving range. However, it is important to consider both metrics in this assessment, because both aspects are important to the consumer experience: efficiency is a major factor in recharging costs and driving range affects the convenience of driving BEVs.

RESULTS

In 2024, the majority of manufacturers (17 out of 21) showed a rise in driving range from 2023. The average driving range across all manufacturers continued to increase, from 419 km in 2023 to 431 km in 2024. However, driving range varied considerably among the 21 manufacturers, from 229 km for Mazda on the low end to 537 km for Tesla on the high end. Figure 6 shows the average driving range of ZEV models and the final score for each manufacturer. Red dots show the corresponding 2023 value on this metric for each automaker. More detailed score comparisons between 2023 and 2024 are shown in Appendix B, Table B4.

Figure 6

Fleet-average driving range of ZEVs and metric score by manufacturer



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Seventeen manufacturers saw improvements in driving range, largely due to the introduction of new, higher-range models. Only three manufacturers experienced declines; all of them were minor and were mainly due to changes in fleet composition.

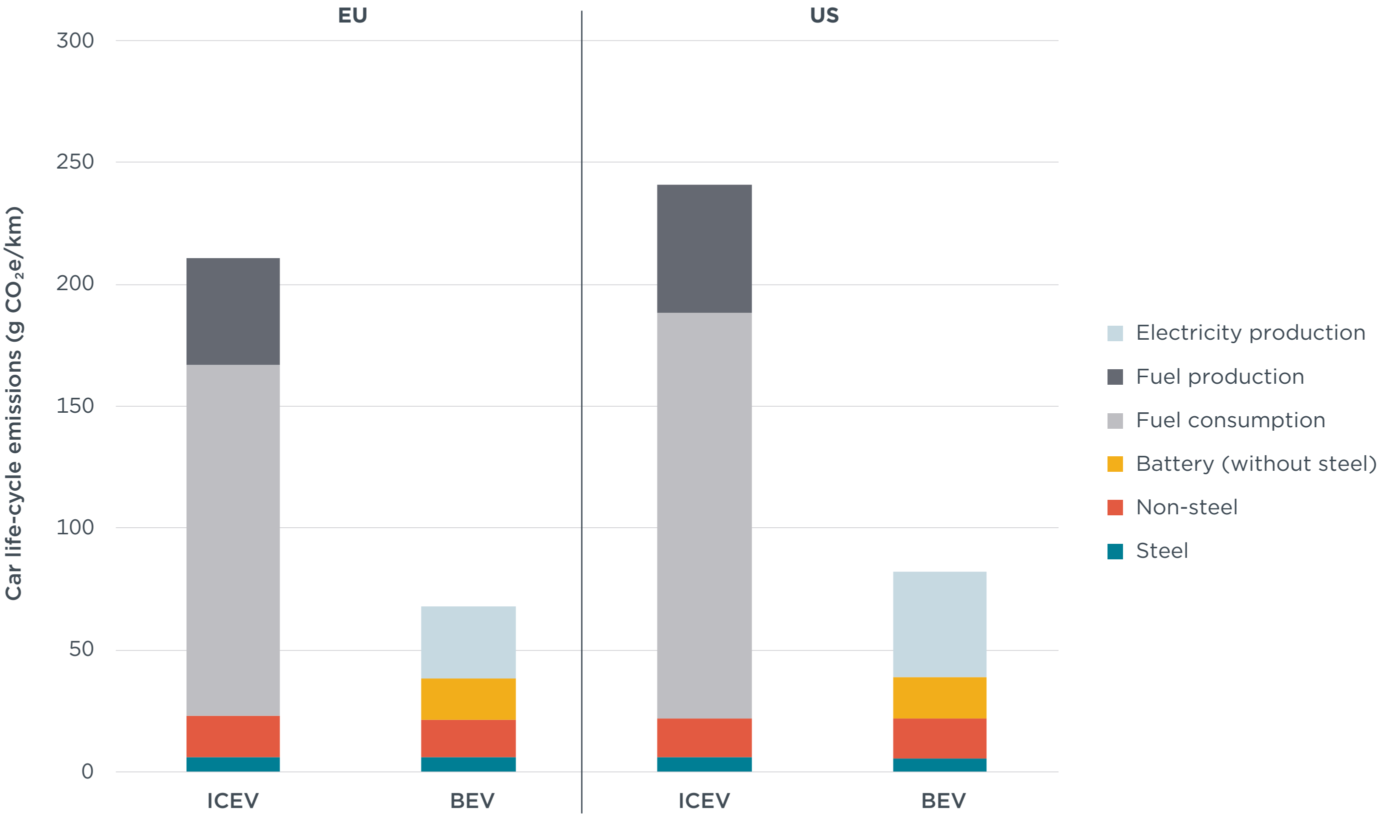
Both GM and Honda showed strong improvement in driving range—increases of 72 km and 124 km, respectively, meant they reached 517 km (GM) and 510 km (Honda)—enough to make them the best performers following Tesla. These substantial gains were achieved by expanding previously limited BEV portfolios with longer-range models. The Honda Prologue, introduced in 2024, accounted for 58% of Honda's total ZEV market share and offers a range of 512 km. For GM, the Blazer EV and Equinox EV—with electric driving ranges of 600 km and 616 km, respectively—contributed significantly to overall range improvements. The Blazer EV was first offered for sale in mid-2023, and deliveries of the Equinox EV began in May 2024.

Chery and Chang'an improved fleet-wide driving range by shifting sales toward premium brands. Chery's best seller in 2024—the iCAR 03, with an electric driving range of 483 km—replaced its 2023 best-seller, the QQ Ice Cream, which has an electric driving range of 148 km. Additionally, Chery's premium brand Luxeed gained traction, and the high-range R7 model (685 km) reached a 13% market share. Chang'an's improvements were largely due to the success of premium brands Deepal and Avatr, which offer high-range models. The Deepal SL03 has a range of 613 km.

4.4 Green steel

As the industry shifts toward ZEVs, manufacturing emissions will become an increasingly large share of the emissions from vehicles and thus an important focus of decarbonization efforts. Figure 7 disaggregates life-cycle emissions for ICEVs and BEVs in the European Union and United States. Although steel is currently only about 2% of the life-cycle GHG emissions of manufacturing and operating gasoline cars in those regions, it is 7% for BEVs because of the far lower emissions from their fuel cycle (Bui et al., 2024). Steel is also one of the biggest contributors to ZEV manufacturing emissions (together with battery production and aluminum) and steel procured by automakers globally currently has a higher emissions intensity than the steel industry's average (Negri et al., 2024). To fully decarbonize vehicles, automakers must shift toward procuring steel with lower GHG intensity. (Note that we evaluate actions related to the battery supply chain separately, in Section 4.5.)

Figure 7
Contributions to total vehicle life-cycle emissions



Source: Bui et al., 2024.

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Previous editions of our *Global Automaker Rating* evaluated the use of renewable energy in vehicle and battery manufacturing and assembly processes. The change of the metric to focus on steel reflects the reality that automaker choices likely have greater influence over the pace of decarbonization in the steel industry than over renewable electricity. Globally, auto manufacturing accounts for 12% of total steel demand (World Steel Association, 2024), and the steel industry is not moving especially quickly toward lower-GHG technologies. In contrast, the electricity sector is increasingly turning toward renewables without substantial pressure from the auto industry. If automakers collectively demand lower-GHG steel, it could have a large pull on the steel market.

Steelmaking is an emissions-intensive process because it uses substantial amounts of coal. Among the strategies to reduce emissions, two pathways are mature enough for near-term adoption. The first involves replacing steel produced via the coal-based blast furnace-basic oxygen furnace (BF-BOF) process with direct reduced iron (DRI) and an electric arc furnace (EAF). Instead of coal, DRI can use either natural gas or hydrogen. Using DRI with renewable electrolysis hydrogen, in combination with a renewable electricity-powered EAF, would cut the emissions intensity of steel by more than 95% (Bui et al., 2024). The second strategy combines better recycling of vehicles with the use of the additional recycled steel in new vehicle production. In the European Union, the ICCT estimated that requiring the use of up to 30% recycled steel from end-of-life vehicles could be feasible with better vehicle end-of-life management and could cut steel-related emissions by 20% compared with using solely primary steel (Negri & Bieker, 2025).

Of all the ironmaking capacity installed globally in 2024, 89% was based on the traditional coal-based BF-BOF pathway and the other 11% was based on a natural gas DRI pathway (Global Energy Monitor, n.d.). It is relatively easy to retrofit DRI facilities to use hydrogen instead of natural gas, but to decarbonize the rest of the industry, a shift from blast furnaces to DRI will be necessary. Thus, decarbonizing steel production at a rate aligned with the targets of the Paris Agreement will require significant investments in shifting technology (International Energy Agency, 2021). Because the automotive sector represents a large portion of global steel demand, the industry can lead investments in scaling up fossil-free primary steel production capacities and a more circular use of steel. Automakers can commit to procuring steel produced in the green hydrogen-DRI pathway once more of it becomes available, and this would support the confidence in future demand needed to deploy investments.

METHODOLOGY

For our rating, we defined two types of steel based on the GHG emissions intensity associated with their production: near zero-emission steel and CO_2-reduced steel. Near zero-emission steel, also known as fossil fuel-free or green steel, is produced by eliminating as much coal and natural gas as technically possible in the ironmaking and steelmaking processes and instead using inputs such as green hydrogen or renewable electricity combined with any amount of steel scrap. The other type, CO_2-reduced steel, is produced by eliminating as much coal as technically possible in the ironmaking and steelmaking processes and instead using technologies that are near-zero emissions already or projected to become near zero-emission in the future (even if inputs are not fully renewable) combined with any share of steel scrap. For example, a DRI facility using natural gas would count as a CO_2-reduced pathway. Alternatively, the criteria can be met with other technologies that reduce the Scope 1, 2, and 3 GHG emissions intensity of steel by at least 50% compared with the global average emission intensity of the BF-BOF pathway of 2.5 tonnes of CO_2-equivalent (CO_2e) per tonne of steel.

This green steel metric evaluates current and future efforts to source lower emission steel for vehicle production. It is based on three factors that are weighted equally: an automaker's 2024 steel GHG emissions intensity, green steel targets, and green steel offtake agreements. The steel emissions intensity refers to the average emissions intensity in tonnes of CO_2e per tonne of steel purchased by the automaker in 2024. Green steel targets refer to automakers' announced targets for green steel or CO_2-reduced steel by 2030. Green steel offtake agreements consider any steel procurement arrangements signed by automakers, whether through binding or non-binding commitments with steel producers.

Steel GHG emissions intensity

We estimated the GHG emissions intensity of steel following the methodology used in a 2024 ICCT study (Negri et al., 2024). The approach combines data on supply chain connections between automakers and steel producers with estimates of steel GHG emissions intensity in the countries in which steel producers operate. We used Bloomberg's Supply Chain dataset, which identifies customer-supplier relationships and quantifies the financial value of transactions between companies. We assumed that direct connections between automakers and steel producers refer to the exchange of steel products to be used in vehicle production, as the dataset does not specify the exact products exchanged between the companies.

The financial value of exchanges between companies is at the global level and does not identify where the trade flows occurred. We therefore sourced steel production plant locations by country from the Global Steel Plant Tracker from Global Energy Monitor (n.d.). Production data by region for automakers were retrieved from MarkLines (n.d.) and our analysis assumed that automakers buy steel from plants in the same region where they produce the cars. As noted in previous ICCT research (Negri et al., 2024), interregional trade of steel is lower than intraregional production and consumption. The regional divisions used in our analysis are listed in Appendix C.5.

To calculate emissions intensity, we attributed the average emission intensities of steel produced in a given country to a steel producer's installed capacity in that country (Hasanbeigi, 2022). With the resulting average emissions intensity of a steel producer in a given region, we estimated the automakers' emissions intensity by weighting their steel suppliers' regional emissions intensity by their regional share of supply. Finally, we estimated the automakers' global average emissions intensity by weighting the regional values based on their share of vehicle production in each region.

Due to limited data availability and information from automakers regarding their steel supply chains and emissions intensity, these estimates have some limitations. First, estimates of automakers' shares of supply from steel producers were based on financial data and not actual quantities exchanged between companies. Second, we only considered the supply chain connections between automakers and steel producers captured in Bloomberg's dataset, and those depend on the level of disclosure of companies themselves (e.g., in annual reports, official press releases, or other public announcements). More systematic disclosure would allow for a more robust estimate of the emissions intensity. Finally, our analysis did not consider interregional trade, which is a relatively low share of overall steel consumption.

Our engagement with automakers allowed us to validate some of the information used in the analysis. Where additional information provided by automakers was publicly available, we incorporated it into our analysis; otherwise, original values were retained.

Green steel targets

We scored automakers' future steel targets based on their publicly announced procurement plans for near zero-emission or CO_2-reduced steel by 2030 for LDV production. Scores are based on the share of committed steel procurement of the automakers' total global steel demand. An automaker received 1 point for a commitment to near zero-emission steel targets and 0.5 points for a commitment to CO_2-reduced steel. Appendix C.6 presents the details of this calculation. Procurement commitments were generally linked to automakers' participation in green steel initiatives like the First Movers Coalition (FMC; 2024) or SteelZero (Climate Group, 2024), which set steel procurement targets. VW has not announced a steel target but has signed offtake agreements that show the company is committed to decarbonizing a fraction of its steel supply; accordingly, we also gave VW credit for this amount in the steel target factor. In cases where the commitment applied only to a subsidiary or specific market, we adjusted the scores based on the production share. -

Green steel offtake agreements

For offtake agreements, we first quantified the value of the contract, memorandum of understanding (MOU), or letter of intent (LOI) as a proportion of the automaker's total steel demand in 2024. We define a contract as a secured, legally enforceable, and binding agreement between parties that defines terms and conditions, and the consequences of violating them. The MOUs and LOIs are non-binding agreements between parties that do not contain legally enforceable promises or penalties. Similar to the assessment of green steel targets, we considered only agreements with near-zero emission or CO_2-reduced steel for LDV production. We considered additional data provided directly to us by automakers when this could be confirmed with publicly available information.

If the quantity of steel in an offtake agreement was not specified, we assigned a default value equivalent to approximately 0.2% of an automaker's total steel demand, based on half the share of the lowest known quantified contract, VW's contract with Stegra (2023), which accounted for 0.4% of VW's steel demand. This ensured equal scoring of agreements with unknown quantity and may help encourage more robust disclosure from automakers related to green steel procurement. We applied an adjustment factor of 50% if the agreement was a non-binding MOU or LOI rather than a contract. Appendix C.7 presents the details of this calculation.

Scoring

We converted the score of each factor to a 100-point scale using Equation 1. The automaker with the best performance received a score of 100 and the worst performer received a score of zero. All other automakers were scored based on their relative points compared with the best and worst performers. We then averaged the benchmarked scores of the three individual factors and converted them to a 100-point scale using Equation 1.

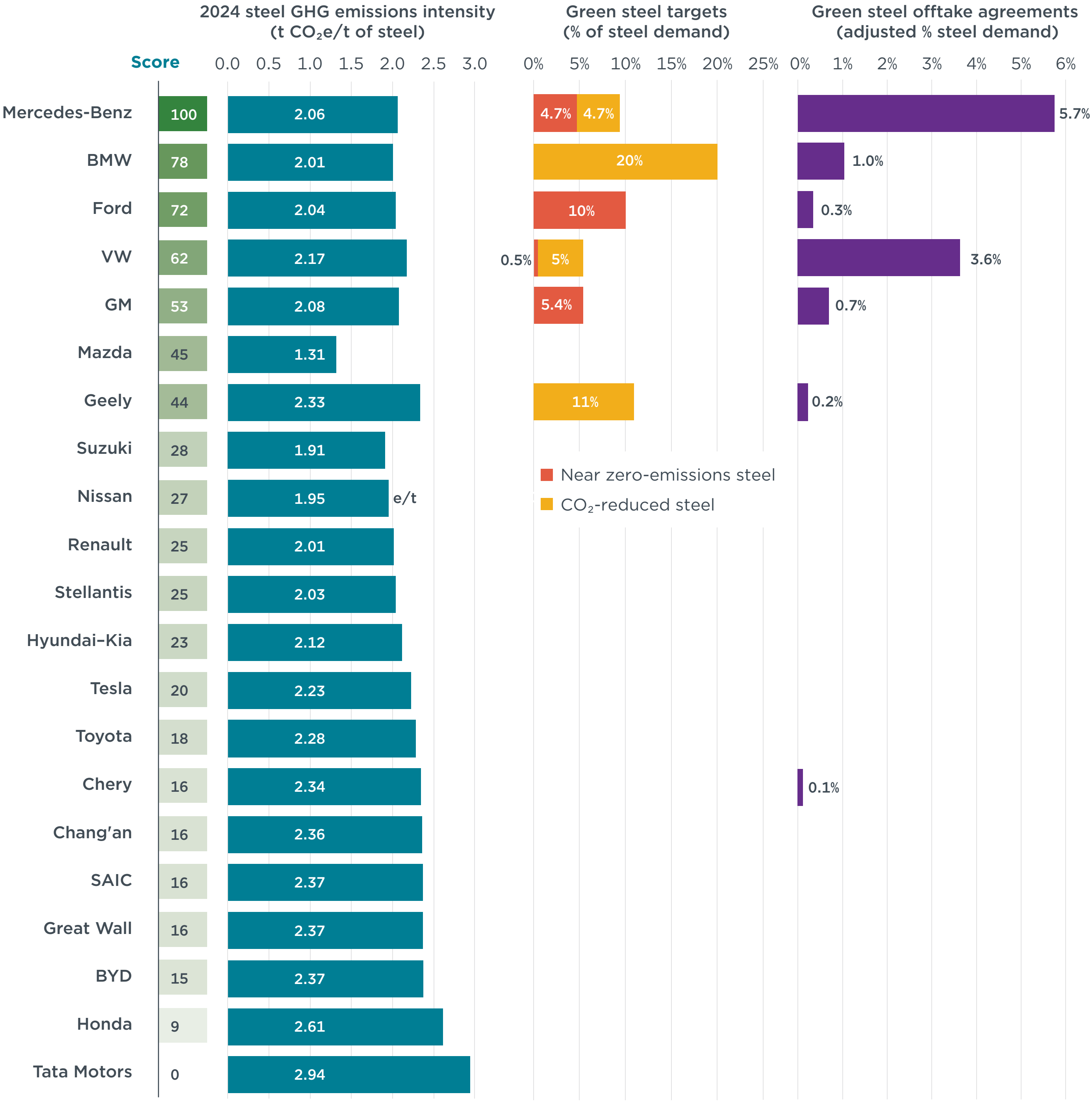
RESULTS

The green steel metric score reflects both the existing efforts and the future vision of automakers to decarbonize vehicle production through reducing steel-related emissions. In 2024, the 21 automakers varied in terms of current steel GHG emissions intensity. Only six had announced steel targets to procure near zero-emission or CO_2-reduced steel in the future, and seven had secured offtake agreements. The automaker scores for each factor and for the green steel metric overall are shown in Figure 8.

Mercedes-Benz received the highest overall score, and was followed by BMW, Ford, VW, and GM. Most of the automakers had an estimated global average emissions intensity between 2.0 and 2.3 tonnes of CO_2e per tonne of steel. The top 5 automakers all had green steel targets and green steel offtake agreements. Outside of the top 5, Geely ranked seventh and had both a steel target and offtake agreement through its subsidiary Volvo Cars.

Figure 8

Green steel metric score by manufacturer



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Mercedes-Benz's high score is due to its lower-than-average steel GHG emissions intensity and the strength of its announced steel targets and existing offtake agreements. The automaker has announced a goal of procuring more than 200,000 tonnes of "CO_2-reduced steel" annually for its European facilities from European suppliers before 2030; this represents more than 9% of its 2024 steel demand (Mercedes-Benz Group, 2023a). The company has also signed supply contracts totaling 100,000 tonnes with Stegra and Steel Dynamics, Inc. (Mercedes-Benz Group, 2023a, 2023b). These agreements, classified in this study as near zero-emission steel, accounted for roughly 5% of Mercedes-Benz's global steel use in 2024. In addition, Mercedes-Benz has secured supply contracts for EAF steel from Salzgitter AG, Arvedi, and Nucor, and signed several LOIs with steelmakers (Mercedes-Benz Group, 2023a).[9]

Several other automakers have set green steel targets. Ford and GM are members of the FMC and thereby commit to at least 10% (by volume) of near-zero emission steel annually for crude steel purchases by 2030 (Ford, 2022a). For GM, this only applies to operations in the United States, Canada, and Mexico, regions that accounted for about 54% of the company's steel use in 2024 (GM, 2023; MarkLines, n.d.). BMW has announced plans to source "low-carbon steel" for over 40% of its demand at European plants by 2030 (BMW, 2022a). Volvo Cars, which accounted for 23% of Geely's steel use in 2024, is a member of the SteelZero initiative, whose members commit to meeting 50% of steel requirements with lower emission steel by 2030 (Volvo Cars, 2021; The Climate Group, n.d.; MarkLines, n.d.).

In addition to Mercedes-Benz, six automakers—VW, BMW, GM, Geely, Ford, and Chery—have signed offtake agreements for near zero-emission and/or CO_2-reduced steel. VW was the second-best performer in this metric component with five offtake agreements, including an MOU with Vulcan Green Steel (Volkswagen Group, 2024a), a contract with Stegra for its subsidiary Porsche (Stegra, 2023), and a contract with Salzgitter AG at its EAF plants (Salzgitter, 2024a, 2024b). The amounts in these agreements add up to roughly 5.5% of VW's 2024 steel use. As the company did not have an explicit steel target in place, we used these known steel percentages as a proxy for the green steel target factor. VW also has MOUs with Salzgitter AG and Thyssenkrupp for the supply of "low-CO_2 steel" (Volkswagen Group, 2024b; Salzgitter AG, 2022).

BMW has contracts with multiple steelmakers (Stegra, 2022; BMW Group, 2022b) and, since 2023, an MOU with HBIS Group (BMW Brilliance, 2022). GM has secured steel contracts with U.S. Steel, ArcelorMittal, and Nucor (U.S. Steel, 2024; ArcelorMittal, 2023; Lopez, 2021). Volvo Cars has a contract to source steel from SSAB by 2026 (Volvo Cars, 2022). Ford has signed three MOUs, one each with Salzgitter AG, Thyssenkrupp, and Tata Steel (Ford, 2022b; Tata Steel, 2022). Chery has signed an MOU with Baosteel for CO_2-reduced steel that starts in 2026 (MarkLines, 2023). Some automakers have referenced closed-loop steel recycling systems in public documents, but did not receive scores for these because no publicly available details of the steelmakers and technology used were found. All targets and agreements are listed in Appendix Table A1 and Table C9.

The remaining automakers have not publicly announced steel targets or agreements to secure near zero-emission or CO_2-reduced steel. This includes Japan-based automakers such as Mazda, Suzuki, and Nissan. The lack of information disclosure on steel emissions intensity from automakers increases the uncertainty of the results. As this report accounts for announcements by the end of 2024, we are not yet considering Hyundai's steel investment announced in March 2025 (Jin & Lee, 2025).

4.5 Battery recycling and repurposing

Increased ZEV production means higher demand for raw materials used to produce batteries and a larger share of emissions from battery material sourcing, extraction, and processing. A 2024 ICCT study projected that global demand for LDV batteries

9 Mercedes-Benz procured near zero-emission steel from SSAB for use in its prototype vehicles. No further details on future collaboration have been disclosed, so we excluded this relationship from our analysis (Mercedes-Benz Group, 2023a).

would grow 11-fold between 2023 and 2050, largely driven by increasing BEV sales (Li et al., 2024).

Battery recycling and repurposing can reduce demand for raw materials by recovering critical materials to produce new batteries or reusing batteries for second-life applications.

A well-established battery recycling system allows for the recovery and reuse of valuable materials such as lithium, cobalt, and nickel from retired batteries to produce new batteries; this reduces the demand for new raw material mining and emissions associated with mineral extraction and processing. At a global level, battery recycling could reduce raw material demand for lithium by 1% in 2035 and 16% in 2050, and for nickel and cobalt by 1% in 2035 and 18% in 2050 (Li et al., 2024).

Battery repurposing involves reusing batteries after the end of their first useful life in other applications, such as for backup power or stationary energy storage; this reduces the need for new battery production. Electricity consumption and emissions from the grid can also be decreased by integrating repurposed batteries as energy storage in renewable energy installments like solar panels at vehicle manufacturing facilities.

We expect automakers to increasingly incorporate battery recycling into their manufacturing supply chains as the ZEV market grows. In addition to reducing manufacturing emissions, battery recycling can directly reduce automaker costs by recovering key materials.

METHODOLOGY

In this edition of the report, we updated the scoring of this methodology to reflect the various phases of manufacturers' efforts to develop battery recycling and repurposing systems.

A manufacturer received 1 point if it had already started operating a battery recycling or repurposing project in a market. We awarded 0.5 points if a manufacturer had indicated efforts or plans to prepare for battery recycling or repurposing but there was no evidence that the project was already in operation. Examples include if an automaker had signed an agreement with a battery recycling partner for a pilot project, established a joint venture, or invested in a battery recycling company. If a manufacturer had recycling and repurposing efforts in the same region but at different implementation phases, we chose the most advanced project that would result in the highest score for manufacturers. A manufacturer received zero points when it had no projects, plans, or initiatives in a given market.

The final score is the sales-weighted average of points across the six markets analyzed. We converted these final scores to a 100-point scale using Equation 1. The manufacturer with the historical best performance received a score of 100 and the historical worst received a score of zero. Other manufacturers were scored based on their relative points on the metric compared with the historical best and worst performers.

We did not differentiate recycling projects based on the recycling capacity or repurposing scale. While sales of new EVs continue to ramp up, the volume of end-of-life batteries from EVs that can be recycled remains low, with most recycling coming from production scrap. Therefore, there is still a lack of sufficient information to compare recycling capacities and the emissions-reduction impact of those efforts.

RESULTS

While some manufacturers made progress in battery recycling and repurposing in 2024 by implementing in-house recycling processes and forming partnerships and joint ventures with recycling companies to establish closed-loop battery systems, others showed little advancement.

Table 2 summarizes manufacturers' battery recycling and repurposing efforts across the six markets in 2024. The symbol indicates that a manufacturer had a battery recycling system project and the symbol indicates that a manufacturer had a battery repurposing project. The colors indicate the stage of such efforts as of 2024, with teal for projects already being implemented and black for projects in development. Percentages in the table indicate the market share of LDVs for a given manufacturer in the markets where manufacturers have deployed battery recycling or repurposing projects. A cell with market share data but without any symbol means the manufacturer has no battery recycling or repurposing project in that market.

Table 2

Battery recycling and repurposing score by manufacturer

OEM	China	U.S.	Europe	Japan	India	Korea	2024 Score	2023 Score	Score changes
Tesla	41%	37%	20%			2%	100	100	0
Great Wall	99%		<1%				99	100	-1
BYD	99%		1%	<1%	<1%		99	100	-1
Stellantis	2%	33%	64%	1%	<1%	<1%	97	99	-2
Geely	78%	5%	16%	<1%	<1%	1%	97	98	-1
Tata Motors	8%	9%	14%	1%	67%	<1%	94	81	13
Renault	1%		93%	<1%	2%	2%	93	95	-2
Mercedes-Benz	34%	17%	43%	2%	1%	3%	91	93	-2
BMW	32%	18%	42%	2%	1%	4%	84	93	-9
SAIC	84%		13%		3%		84	83	1
GM	17%	82%	<1%	<1%		1%	82	74	8
Ford	7%	66%	27%	<1%		<1%	79	92	-13
VW	40%	9%	49%	1%	1%	<1%	78	97	-19
Toyota	24%	32%	15%	25%	4%	<1%	68	59	9
Hyundai-Kia	4%	35%	22%	0%	17%	22%	61	100	-39
Chang'an	100%						50	100	-50
Chery	99%		1%				49	100	-51
Honda	28%	46%	2%	22%	2%	<1%	36	42	-6
Nissan	26%	39%	14%	20%	1%		34	33	1
Suzuki			8%	26%	66%		0	0	0
Mazda	10%	52%	21%	17%			0	0	0

= recycling = repurposing (teal = in operation; black = in development)

Tesla, Great Wall, BYD, Stellantis, and Geely were the top five performers in this metric. They operated in-house recycling facilities and maintained recycling and repurposing partnerships in their dominant markets. Tesla continued its battery recycling activities at its on-site facilities, scaled up activities at its gigafactories in the United States, and collaborated with recycling companies. Great Wall operated a battery recycling system through its subsidiary Honeycomb Energy, and BYD implemented repurposing projects in collaboration with GEM Co Ltd. and ITOCHU Corporation for energy storage systems.

Stellantis continued operating recycling and repair centers in Europe and the United States and expanded second-life solution projects for energy storage through its Free2move eSolution joint venture with NHOA Energy. Geely showed efforts to scale up recycling and repurposing efforts in China through its subsidiary VREMT, and in Europe and the United States through subsidiary Volvo Cars' partnership with local recycling companies.

Jaguar Land Rover (JLR), under Tata Motors, expanded recycling efforts to China through its joint venture with Chery and investments in battery recycling. Toyota received a higher score because it expanded its battery recycling and repurposing efforts in China, although this project remains at an early stage. Toyota also maintains recycling and repurposing operations in Japan and a partnership with Redwood Materials in the United States. Other manufacturers, including Renault, SAIC, and GM, focused on battery recycling and repurposing activities in their dominant markets.

Under the new methodology, some manufacturers that have conducted research, entered cooperative agreements with recycling partners, or announced plans to expand recycling efforts received lower scores due to a lack of public information about the implementation status of recycling or repurposing activities. BMW announced both battery recycling and repurposing expansion to China and the United States in addition to operating its in-house recycling and repurposing in Europe. Additionally, VW announced its partnership with Huayou Recycling to start repurposing batteries for energy storage systems in China, though the status of that operation remains unclear. Mercedes-Benz announced an expansion of recycling and repurposing efforts to China and the United States, but there was no evidence of operation for the repurposing in China in 2024, and this resulted in slightly lower scores. In addition to its battery recycling activity with Redwood Materials in the United States, Ford stated that it has participated in EV battery pilots in Europe, but as there is no public indication of its operation, it received a lower score.

Similarly, Chery signed a cooperation agreement with Guanghua Technology and conducted research on battery traceability. Chang'an announced a recycling partnership with Ganfeng Lithium, based in China. Hyundai-Kia partnered with Hyundai GLOVIS and Hyundai MOBIS for a global battery collection network and remanufacturing business. As above, it is unclear whether these automakers had already started to recycle or repurpose batteries as of 2024.

Among Japan-based manufacturers, Honda and Nissan have projects in their secondary markets: the United States and Europe for Honda and Japan and the United Kingdom for Nissan. Meanwhile, as of 2024, Mazda and Suzuki had not announced battery recycling or repurposing efforts for EVs. While both manufacturers have operated battery recycling programs for hybrid batteries, it is unclear whether these technologies can be applied for recycling batteries from BEVs. Thus, we gave no credit for Mazda or Suzuki's efforts.

5
STRATEGIC VISION

5 STRATEGIC VISION

5.1 ZEV target

The ZEV target metric evaluates the ambition of a manufacturer toward transitioning to a 100% ZEV fleet relative to the pace needed to meet the Paris Agreement. An ambitious target can demonstrate a manufacturer's commitment to keep pace with the ZEV transition. In contrast, a weak ICEV phaseout target or the absence of any target at all may signal that a manufacturer is less likely to invest in ZEV technologies in the near term. This metric is assessed by reviewing and comparing manufacturers' announcements pertaining to their ZEV goals.

METHODOLOGY

The primary sources of ZEV target information were manufacturers' sustainability reports, announcements, press releases, and news articles as of the end of 2024. Several manufacturers announced electrification targets pertaining to all or some of their fleets. These targets vary in terms of time frame (2025, 2030, or 2035), geographical coverage (global or regional), segments covered (only PCs, or all LDVs), and technology types (only ZEVs, or ZEVs and PHEVs).

We set the same benchmarks as in the previous report for ZEV targets in the six major markets—77% by 2030 and 97% by 2035—as these are the levels of ZEV sales our modeling has found would be necessary in the leading markets to keep the world on track to meet Paris Agreement goals (Sen & Miller, 2023).[10] We derived the ZEV target score by calculating the ratio of a manufacturer's ZEV sales target to its corresponding benchmark; that is, a ZEV target for 2030 was compared with the 2030 benchmark and a ZEV target for 2035 was compared with the 2035 benchmark. In cases where manufacturers only had a target for 2025, which was mainly the case for China-based manufacturers, we compared that target against the 2030 benchmark and assumed the ZEV market share would not grow beyond 2025 in the absence of a target for 2030 or 2035.

The ratio of a manufacturer's ZEV sales target to the benchmark can be larger than 100% if the manufacturer's target was more ambitious than the benchmark. For example, GM received a target score of 103% after its 2035 target of 100% ZEVs was benchmarked to the 2035 ZEV target of 97%.

We averaged the scores of the 2030 and 2035 targets in cases where an automaker had to account for any changing signals from manufacturers, some of which have lowered the ambition of 2030 targets from what they originally announced. All manufacturers that announced 2035 targets have also set 2030 targets, so this revised methodology allowed us to account for the less ambitious 2030 targets of all automakers.

Some manufacturers had multiple ZEV targets with different scopes that apply to certain regions, subsidiary brands, or vehicle types (i.e., only PCs or all LDVs). For each manufacturer, we calculated the sales-weighted average score based on the vehicle sales in each market with a target. Some manufacturers' announcements of ZEV targets were worded generally to apply to sales in "leading markets." We assumed that this included all six regions assessed in this analysis unless a different scope was

10 Major markets in Sen and Miller's (2023) analysis included China and the members of the ZEV Transition Council: Canada, Denmark, France, Germany, India, Italy, Japan, Mexico, Netherlands, Norway, Spain, Republic of Korea, Sweden, United Kingdom, and the United States.

clarified in the automaker's statement. We then calculated the sales-weighted average score of the different targets, if any, for each manufacturer.

We considered BEVs, FCEVs, and the ZEV-equivalent portion of PHEVs when calculating ZEV targets. Although most manufacturers set their targets for only ZEVs, some, notably those based in China, had only announced EV targets that included both BEVs and PHEVs without specifying shares for each powertrain. For these manufacturers, we discounted the EV targets for the PHEV share of their 2024 total EV sales based on real-world data on the electric driving share of PHEVs, following the methodology we used to calculate the ZEV-equivalent sales share in Section 3.1. For instance, Great Wall set an EV target of 80% by 2025 and had a ratio of 0.66 between its ZEV-equivalent sales and total EV sales in 2024. Therefore, we multiplied 80% by 0.66 to obtain a 53% ZEV-equivalent target.

Targets that included conventional (non-plug-in) hybrid vehicles were not considered as a ZEV target in the scoring because conventional hybrid vehicles cannot be recharged with electricity and thus there is no zero-emission component to their operation. Furthermore, an electrification target that includes hybrids could potentially be dominated by hybrids, without any guarantee of the automaker investing in a ZEV future.

We converted the ZEV target ratios to a 100-point scale using Equation 1. We then assigned a score of 100 to the historical best performer and zero to the historical worst performer of this metric. Per Equation 1, manufacturers' ZEV targets were scored relative to the historical best and worst performers.

RESULTS

Tesla, which only produces ZEVs, and Stellantis, which has committed to reaching a 100% ZEV sales share for PCs in Europe and 50% share for LDVs in the United States by 2030, ranked first in the ZEV target metric in 2024. Although BYD produced 100% EVs, it received a partial score based on its ZEV-equivalent sale share because it still produces PHEVs and has not announced a target for phasing them out. Some manufacturers saw increases in scores, including Chang'an and Kia (a Hyundai-Kia subsidiary), which increased their ZEV sales targets, and Nissan, which announced a ZEV target separate from its e-POWER hybrids. In contrast, Volvo Cars (Geely) revised down its 100% ZEV target to 90% EVs by 2030, while Dacia (Renault) and Genesis (Hyundai-Kia) removed their 100% ZEV sales targets.

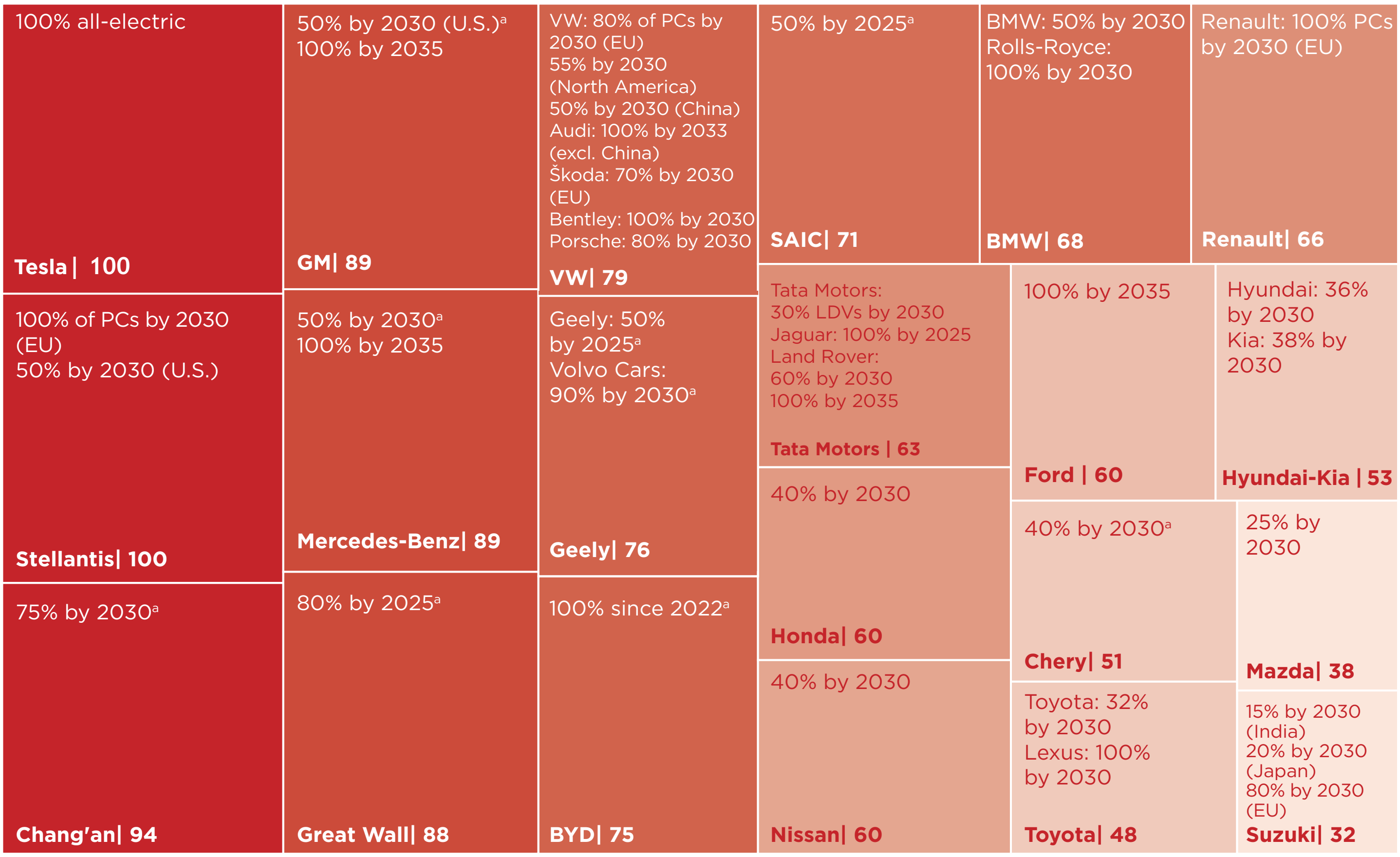
Among manufacturers that also produce ICEVs, seven maintained 100% ZEV targets for at least one brand in leading markets. Jaguar (Tata Motors) had a 100% ZEV target for 2025, while Rolls-Royce (BMW), Lexus (Toyota), and Bentley (VW) all had 100% ZEV targets for 2030.[11] Audi (VW) had a 100% ZEV target by 2033 and GM, Ford, Mercedes-Benz, and JLR (Tata Motors) by 2035.

Figure 9 summarizes the ZEV sales targets for each auto manufacturer at the global and regional levels, including the targeted market share, target year, vehicle technology, vehicle segment, and the final score for the ZEV target metric after rescaling. Table B5 in Appendix B further details the score changes.

11 Lexus's 100% ZEV target in North America, China, and Europe by 2030 is not shown in Figure 9. Toyota's score is based on Toyota's corporate-level target because it results in a better score for Toyota.

Figure 9

Announced EV sales targets and metric score by manufacturer



[a] ZEV target includes plug-in hybrid electric vehicles

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Several manufacturers raised their EV targets or set new ones. Chang'an increased its global 2030 EV (BEV and PHEV) target from 60% to 75%. Under Hyundai-Kia, Kia increased its global 2030 ZEV target from 37% to 38% and Hyundai increased its target from 30% to 36%. Nissan received a higher score than in 2023 for its 2030 target of 40% ZEV sales because it newly specified the associated EV sales share target, which previously included e-POWER hybrids. In addition, while Honda set a new regional target of 100% by 2035 in China, this is not reflected in its score because the manufacturer has a global target of 40% sales by 2030.

Others lowered the ambition of their targets. As signatories of the ZEV Declaration (2021), Ford, GM, and Mercedes-Benz committed to a 2035 target of 100% ZEVs for new LDVs in leading markets; however, all three automakers revised their 2030 targets downward. Volvo Cars announced that it had revised its 2030 target from 100% to 90%–100%, and it now also includes PHEVs. In addition, three brands—Genesis (Hyundai), MINI (BMW), and Dacia (Renault)—dropped previously announced targets of reaching 100% global ZEV sales by 2030, 2031, and 2035, respectively. We removed those targets from our scoring, and it led to downward adjustments for each automaker. Pulling back on ZEV targets can signal uncertainty to consumers and raise concerns among investors and business partners regarding an automaker's commitment and preparedness to fully transition to ZEVs in the long term.

While some manufacturers may not have changed their targets compared with 2023, their scores may have changed due to shifts in PHEV sales shares or in the regional distribution of sales among brands. This includes companies that sold more PHEVs in 2024, including BYD, Great Wall, and Chery. Other Japan-based manufacturers showed no development in their commitment toward the ZEV transition. Toyota maintained a 3.5 million ZEVs sales target by 2030, and that translates to an estimated ZEV sales share target of 32%.[12] Suzuki has committed to reaching ZEV sales targets of 20% by 2030 in Japan, 15% by 2030 in India, and 80% by 2030 in Europe.

Some China-based manufacturers achieved their 2025 EV sales share targets in 2024: Geely and SAIC attained 50% EV sales, while Chang'an reached its target of 40%. Others might not reach their targets unless sales substantially ramp up in 2025. Great Wall, for instance, saw its EV sales share reach 40% in 2024, up from 17% in 2023, but its sales will have to rapidly accelerate to meet the manufacturer's 80% EV target by 2025. Jaguar (Tata Motors), with an EV sales share of approximately 15% in 2024, has even further to go to meet its 2025 target of 100%. Although manufacturers received a score in this report for having set those targets, their scores will significantly drop in future evaluations if they fall short of their commitments.

5.2 ZEV investment

ZEV investment is a measure of a manufacturer's financial commitment to the transition to zero-emission technology. While investment commitments do not by themselves guarantee the ZEV transition, they are an indication of commitment and planning on the part of manufacturers. Investing in ZEVs now reduces the risk that manufacturers will fall behind in the transition.

METHODOLOGY

This metric evaluates a manufacturer's investment in the ZEV transition. We considered research and development expenditures, capital expenditures on ZEV production sites to increase manufacturing capacity, and investment in ZEV supporting infrastructure like battery plants, charging stations, and the broader charging network. We also considered financial outlays for other investment-related activities, like establishing subsidiaries, joint ventures, and partnerships. We collected investment announcements related to raw materials that are used to produce batteries for EVs, such as lithium, cobalt, nickel, and manganese. The supply of these minerals will need to scale up to meet global EV battery demand as the ZEV transition continues, and directly investing in mineral production now may reduce supply chain risk and price exposure for automakers.

Our primary source of investment data was the Atlas EV Hub, a database developed by Atlas Public Policy (n.d.). The database documents EV investments announced by major manufacturers worldwide from 2016 to 2024. We also collected additional investment information from sustainability reports and official press releases to verify Atlas EV Hub data and update the investment data when discrepancies were found. We used information that was verified by manufacturers, such as the percentage of capital expenditure that is allocated for EV investment. We collected information on both the monetary amount and the investment period for ZEV investments that were announced from 2016 to 2024.

12 To infer Toyota's 2030 target from this goal, we estimated the company's global LDV sales in 2030 based on its 2023 global LDV production and an annual growth rate of 2.2% (the compounded annual growth rate of Toyota's global production from 2011–2023) and the Lexus brand's 100% ZEV target by 2030 in North America, China, and Europe.

Some manufacturers announced EV investments in combination with other advanced vehicle technologies such as smart transportation or autonomous driving technology. In these cases, we derived the EV investment amount either from the EV-specific portion that the manufacturers provided or by splitting the investment amount equally between the different types of technologies specified.

For consistency with our previous edition, the total investment was evaluated in terms of 2023 U.S. dollars per vehicle and adjusted for the time value of money by using a discount rate of 3.2%, based on the average of annual inflation rates between 2016 and 2023 calculated by the Organisation for Economic Co-operation and Development (n.d.). This was to account for the varying time frames of announced investments. We first distributed each announced investment evenly across its specified time frame to calculate the annualized investment. In the absence of a stated duration, we assumed an investment period of 10 years given the transitional nature of the current ZEV market, which requires a longer recovery period for investments than would be expected in a more mature market. The investment amount for each year was adjusted to 2023 U.S. dollars. We then summed the present values of these annualized investments to generate the cumulative investment amount in 2023 dollars.

Investment announcements typically did not specify how funding would be allocated across different powertrains. As with the ZEV target metric, we considered BEVs, FCEVs, and the ZEV-equivalent portion of PHEVs when calculating ZEV investment. We adjusted investments using the ratio between ZEV-equivalent share and the actual EV share in 2024, calculated and summarized in Section 3.1.

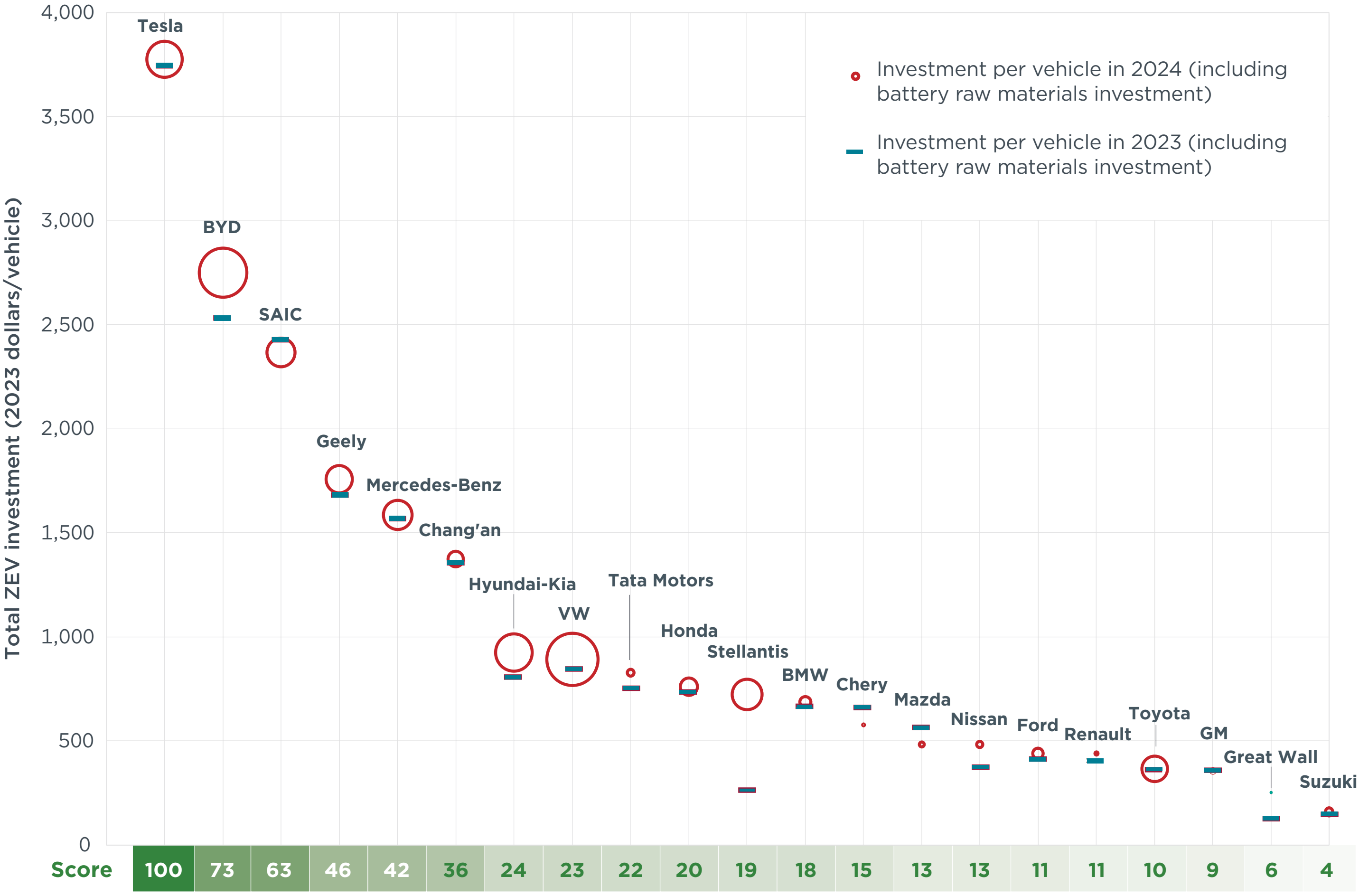
We calculated each manufacturer's investment per vehicle by dividing the cumulative investment amount (in 2023 U.S. dollars) by the product of its average LDV sales in the six major markets for 2022 and 2023 and an investment return period of 10 years. To maintain consistency and enable comparison between reports, we used the same LDV sales averages as in the previous edition to represent the relative size of manufacturers rather than project future sales precisely. We identified the historical best and worst performers and assigned them scores of 100 and zero, respectively; per Equation 1, manufacturers' investment scores were awarded relative to the historical best and worst performers.

RESULTS

Manufacturers' announced financial commitments differed substantially in terms of per-vehicle and cumulative investment values. Figure 10 shows the ZEV investment levels per vehicle in 2024 and 2023, with manufacturers arranged from highest (left) to lowest (right) per-vehicle investment in 2024. Bubble sizes indicate the extent of total investments announced by each manufacturer through 2024 in 2023 U.S dollars. The bars represent the 2023 per-vehicle investment by automakers for comparison. Table B6 in Appendix B provides further detail on the cumulative EV investment announced by each manufacturer, investment values in 2023 dollars, investment in battery raw materials, and EV to ZEV adjustment factors, and compares investment per vehicle in 2024 and 2023.

Figure 10

Per-vehicle ZEV investment and metric scores by manufacturer



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In 2024, 10 manufacturers invested more in the ZEV transition than in 2023, although the increase was minor compared with the increase from 2022 to 2023. Hyundai-Kia announced ₩120 trillion in total EV investment, up from ₩109 trillion in 2023, which brought its per-vehicle investment to $926. This ranked it ahead of the other top-selling automakers, including VW ($892), Stellantis ($723), and Toyota ($377). Tata Motors announced that it will invest approximately ₹16,000 crores ($1.9 billion) in EV production between fiscal years 2025 and 2030.

Tesla continued to lead in terms of investment per vehicle sold ($3,776) and was followed by China-based manufacturers BYD ($2,751) and SAIC ($2,367). Excluding investment in battery raw materials, BYD surpassed VW with the largest total ZEV investment among all manufacturers, with increased financing for vehicle and battery production that included joint investments with Weichai and FAW Group. Geely and Chang'an trailed with investment per vehicle of $1,758 and $1,374, respectively. Among European manufacturers, Mercedes-Benz led with a per-vehicle investment of $1,586, with €40 billion ($45 billion) in EV investment commitments through 2030.

For the remaining manufacturers, no new investments were announced in 2024. Among this group, Honda and BMW scored fairly well, with per-vehicle investment of $760 and $688, respectively. GM, Ford, and Renault stopped disclosing common ZEV investment targets, so their investment amounts reflected the reported ZEV investment through 2024. This resulted in ZEV investments between $360 and $440 per vehicle.

Among Japan-based manufacturers, Suzuki led in cumulative announced investment with ¥2 trillion ($14 billion) in EV financing through 2030, followed by Nissan with approximately ¥2 trillion ($14 billion) for EVs and e-POWER through 2026 and Mazda with ¥1.5 trillion ($10.6 billion) for EVs through 2030. Chery and Mazda saw drops in score due to changes in the PHEV multiplier, though their total investments did not decrease.

As in our last report, we collected information on manufacturers' investments in raw materials, though such data remain limited. In 2024, the 21 automakers did not announce any major investments in battery raw materials. GM finalized a $625 million investment in lithium production capacity that was originally signed in 2023; under this it will partner with Lithium Americas to develop the Thacker Pass mine in Nevada, United States. VW continued to lead in terms of total investment in the minerals supply chain with two main joint ventures, partnering with Umicore in Europe to supply cathode and precursor materials and Huayou Cobalt and Tsingshan Group in China to secure nickel and cobalt. No information was found on investments in the mineral supply chain by Japan-based manufacturers. Table B6 in Appendix B provides additional details on raw materials investments.

Among manufacturers that also produce ICEVs, when comparing reported investments in electrification with total company investments—including capital expenditure (CapEx) and research and development (R&D) expenditure—the share of EV-related spending remained low. Ford's EV investment to total investment ratio was 40% and is expected to decline to 30% in 2025. For European automakers, investments aligned with the EU taxonomy—a classification system to identify environmentally sustainable economic activities, including EV-related spending—ranged between 20% and 37% of total CapEx in 2024.[13] For the EV transition to continue to accelerate, manufacturers must allocate a greater share of investments toward realizing electrification plans.

5.3 Executive compensation alignment

The executive compensation alignment metric is an indicator of the degree of alignment between chief executive officer (CEO) compensation and EVs. Executive compensation is typically structured to encourage CEOs to focus on delivering certain outcomes. Historically, most CEO compensation packages have been linked to short-term financial performance indicators like earnings before interest and taxes and free cash flow; however, investment in the zero-emission transition is a long-term investment that is not reflected in short-term financial performance to the same extent as profits generated by traditional ICEVs. Linking CEO compensation directly to EV development would be an indicator of the importance of the ZEV transition in a company's overall business strategy and suggest a higher likelihood that CEOs will focus on ZEVs.

METHODOLOGY

The evaluation for this metric is based on the compensation structure, performance and financial criteria, and weightings of components used by each manufacturer to determine the compensation of chief executives. The information was extracted from the proxy statements, public filings, and annual reports of each manufacturer. Proxy statements are issued by companies annually and contain information that the U.S. Securities and Exchange Commission and similar institutions in other regions require

13 According to the European Commission (2024), "taxonomy-aligned investments are aligned with a net zero trajectory by 2050 and the broader environmental goals," including the development of EV technologies.

firms to provide to shareholders concerning key topics to be voted on in shareholder meetings as well as executive and board compensation and other information. The proxy statements and other relevant reports reviewed for this rating reflected compensation structures for fiscal year 2024 or the latest previous year available for each manufacturer.

In addition to any fixed salary, chief executive compensation usually includes short- and long-term incentives. Short-term incentives generally reward performance achieved within 1 year, while long-term incentives reward achievement over a longer time horizon, often 3 years or more in the future. The proportions of such incentives vary by manufacturer, and there are cases where an executive's entire compensation package is determined solely by short-term or long-term incentives.

We determined the weight of different types of incentives in an executive's total compensation package based on the manufacturer's stated target compensation framework. In cases where such information was not clearly indicated, we used the proportions of the actual compensation paid for that reporting year. We assumed the target compensation will influence an executive's decision-making to align with the company's strategy. Actual paid compensation incentives, by contrast, are based on a confluence of factors the company management may or may not have control of.

For this metric, we evaluated the percentage of compensation that directly depends on EV development. Besides compensation elements that are clearly linked to EVs, we also gave partial credit for elements associated with CO_2 emissions. We applied an adjustment factor of 50% for CO_2 emission-related elements, because such objectives could be achieved without electrification. We did not adjust for PHEV sales because the split between ZEVs and PHEVs in the compensation incentive was not clear for most manufacturers. This approach kept our analysis at the same granularity across automakers.

We first identified the types of CEO incentives that were linked to EV and CO_2 emissions elements at each automaker. We then calculated the share of executive compensation that was determined by the element. Tesla and BYD, which exclusively produce and sell EVs, received a default score of 100% because all their growth and profits derive from EVs. We identified compensation incentives that are linked to EVs and CO_2 emissions elements among other manufacturers and allocated the scores based on the weight of incentives linked to the two elements. The top-performing automakers received the maximum score along with Tesla and BYD.

We converted the final value of the adjusted compensation percentage to a 100-point scale using Equation 1. We identified the historical best and worst performers from reporting years 2024 and 2023 and assigned a score of 100 to the former and zero to the latter.

RESULTS

As in the previous edition of this report, seven manufacturers, excluding Tesla and BYD, incorporated direct electrification targets into their executive compensation structure. Table 3 presents a list of manufacturers that link compensation incentives to EV development and CO_2 emissions, the weight in the compensation, and the final score. Other manufacturers not in the table did not disclose executive compensation structures linked to either of the elements.

Table 3

Metric scores for executive compensation alignment with EV development by manufacturer

OEM	Element in executive compensation		Percentage of total compensation 2024	Percentage of total compensation 2023	Score 2024	Score 2023	Score changes
	Linkage	Description[a]					
BYD	EV-only manufacturer		100		**100**	**100**	**0**
Tesla	EV-only manufacturer				**100**	**100**	
Stellantis	EV	50% of transformation incentives (21%)	28%	27%	**100**	**100**	**0**
		30% of long-term incentives (51%)					
		12% of short-term incentives (17%)					
BMW	EV	17% of short annual bonus' performance target (29%)	15%	16%	**52**	**60**	**-8**
		50% of share-based remuneration's strategic focus target (16.5%)					
	CO_2 emissions	50% of share-based remuneration's strategic focus target (16.5%)					
Renault	CO_2 emissions	25% of long-term incentives (37%)	5%	6%	**17**	**24**	**-7**
GM	EV	25% of short-term incentives (16%)	4%	15%	**15**	**55**	**-40**
Mercedes-Benz	EV	7% of long-term incentives (36%)	3%	3%	**12**	**15**	**-3**
	CO_2 emissions	8% of annual bonus transformation targets (25%)					
Ford	EV	20% of short-term incentives (12%)	3%	3%	**11**	**11**	**0**
VW	CO_2 emissions	17% of annual bonus (26%)	2%	2%	**8**	**8**	**0**
Honda	CO_2 emissions	7% of long-term incentives (45%)	1%	0%	**5**	**0**	**5**
Nissan	EV	5% of performance-based cash incentives (28%)	1%	1%	**5**	**5**	**0**
Jaguar Land Rover (Tata Motors)	CO_2 emissions	25% of performance-based strategic bonus (33%)	1%	1%	**5**	**4**	**1**
Volvo Cars (Geely)	CO_2 emissions	25% of long-term incentives (5%)	1%	1%	**1**	**4**	**-3**

[a] Percentages in parentheses reflect the size of that compensation element in the total compensation portfolio.

In 2024, Stellantis maintained the top spot among automakers that also produce ICEVs. Three of its compensation incentives were linked to EV targets. In a change from our previous report, however, the automaker reduced the weight of EV development in the short-term incentive from 15% to 12%. This element is determined based on EV market share in the European Union and production in the United States. Stellantis otherwise maintained the share of its long-term incentive determined by EV sales (30%) as well as a CEO "transformation incentive" of €25 million tied to reaching certain goals related to electrification. JLR (Tata Motors) increased the weight of sustainability criteria (2030 CO_2 reduction targets) to 25% of its strategic bonus plan, up from 17% previously. Moreover, for the first time, Honda linked long-term incentives for its CEO to three non-financial indicators, one of which concerned CO_2 emissions: specifically, the amount of CO_2 emissions from corporate activities and products.

In contrast, GM no longer tied its long-term incentives to EV development, and it is now only considered for its short-term incentive, where EV measures account for 25%. For Renault, 25% of the long-term incentives for its top executive is no longer linked to EV development, and is instead now linked to CO_2 emissions reduction.

Other automakers that link their executive compensation to EV development or CO_2 emission reductions made no changes to compensation structure or target weight. For these manufacturers, score changes seen in the table are due to the higher score of the best performer in this edition of the report. Additionally, the share of compensation linked to elements like long-term and short-term incentives may vary from year to year, which affects the resulting EV-related percentages.

Consistent with 2023, BMW linked its short-term bonus to BEV sales share and its long-term variable remuneration (share-based payments) to global sales of BEVs and reductions of fleet carbon emissions in the European Union. Ford continued to link 20% of its short-term annual performance bonus to EV global retail volume, while approximately 20% of Mercedes-Benz's long-term incentive is linked to three ESG targets, one of which is the EV sales share. Approximately 5% of Nissan's performance-based cash incentive was determined by EV development as part of its carbon neutrality efforts, and this made up approximately 1% of total compensation in 2024.

Other automakers that have linked compensation components to CO_2 emission reductions include VW, which links performance criteria for short-term annual bonuses to ESG factors. Such factors include the decarbonization index, which measures the life-cycle CO_2 and CO_2e emissions by PC- and LCV-producing brands. Volvo Cars (Geely) incorporated CO_2 emissions in the determination of its long-term performance share plan; the weight of non-financial criteria in its plan dropped from 30% in 2023 to 25% in 2024.

While some other manufacturers have introduced non-financial indicators linked to ESG factors, no points were awarded to these automakers due to limited publicly available information on the links to EV development or CO_2 parameters and the share of these incentives in total executive compensation. For example, Hyundai-Kia and Toyota have incorporated ESG factors into their performance-based criteria for short-term and long-term incentives, respectively. In 2024, Mazda announced plans to link its restricted stock (long-term) compensation plan to GHG emissions to align with the company's medium- to long-term strategy. Similarly, Geely linked remuneration incentives to annual carbon reduction targets as part of its performance-based evaluation.

6

FINAL RATING RESULTS

6 FINAL RATING RESULTS

This report assessed the progress of the world's top 21 automakers toward transitioning to ZEVs. The companies that prepare now to grow their ZEV market shares are expected to be best positioned for success in the future.

Table 4 shows the final rating of the 21 manufacturers and their score on each of the 10 metrics. The final rating and the score for each pillar—market dominance, technology performance, and strategic vision—are shown in colors. Consistent with previous reports, we categorized automakers into three groups: Leaders within the top third (66.7–100 in overall rating or pillar score, in green), Transitioners within the middle third (33.4–66.6, in yellow), and Laggards within the bottom third (0–33.3, in red). The final rating was calculated by averaging the scores of the three pillars.

Table 4
Overall scores, Global Automaker Rating 2024

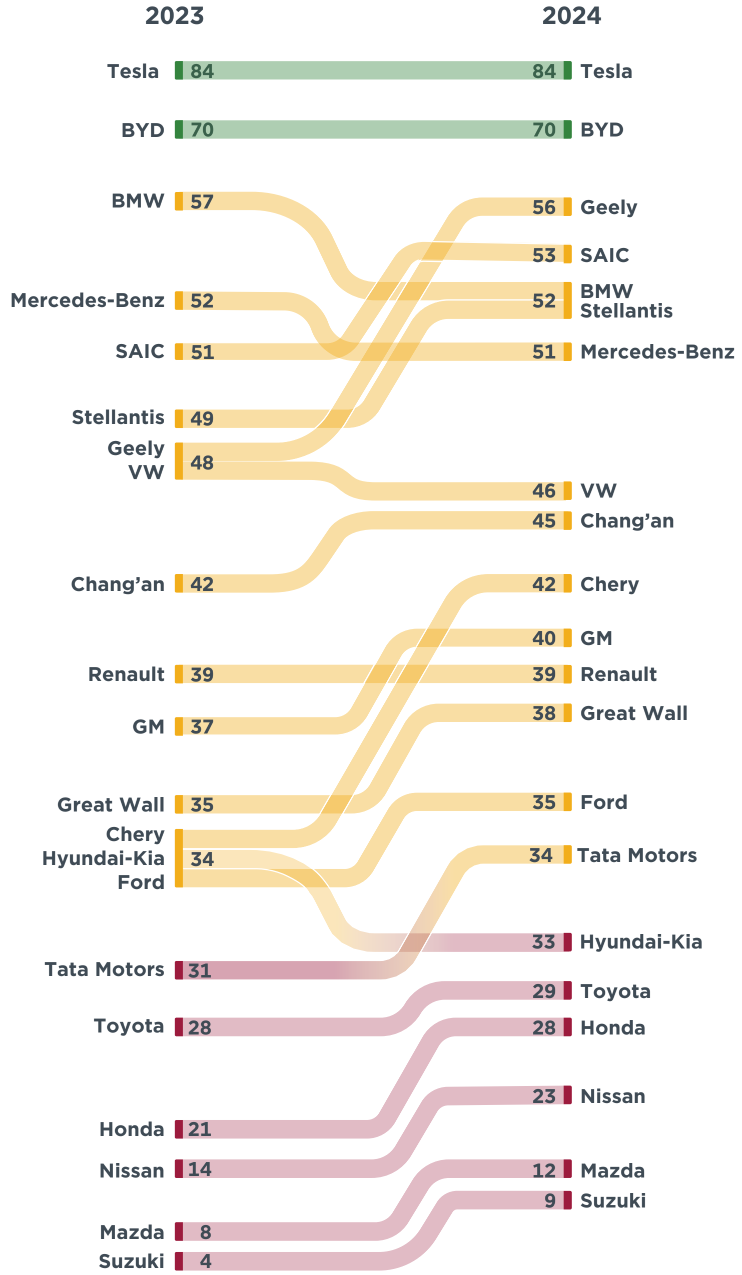
OEM	2024 rating		Market dominance			Technology performance						Strategic vision			
			ZEVe sales share	ZEV class coverage	Pillar score	Energy consumption	Charging Speed	Driving Range	Green steel	Battery recycle/ reuse	Pillar score	ZEV target	ZEV investment	Executive compensation	Pillar score
Tesla	84	LEADERS	100	46	73	82	100	100	20	100	80	100	100	100	100
BYD	70		75	76	76	65	25	60	15	99	53	75	73	100	83
Geely	56	TRANSITIONERS	42	94	68	51	47	63	44	97	60	76	46	1	41
SAIC	53		47	100	74	61	14	29	16	84	41	71	63	0	45
BMW	52		19	54	37	70	51	87	78	84	74	68	18	52	46
Stellantis	52		8	70	39	33	29	38	25	97	44	100	19	100	73
Mercedes-Benz	51		14	52	33	49	44	84	100	91	74	89	42	12	48
VW	46		10	59	35	60	48	88	62	78	67	79	23	8	37
Chang'an	45		34	77	56	52	18	41	16	50	35	94	36	0	43
Chery	42		27	92	60	60	37	59	16	49	44	51	15	0	22
GM	40		6	17	12	75	51	94	53	82	71	89	9	15	38
Renault	39		9	72	41	49	21	36	25	93	45	66	11	17	31
Great Wall	38		26	47	37	39	25	49	16	99	46	88	6	0	31
Ford	35		5	30	18	15	48	85	72	79	60	60	11	11	27
Tata Motors	34		9	35	22	100	5	45	0	94	49	63	22	5	30
Hyundai-Kia	33	LAGGARDS	7	28	18	40	76	73	23	61	55	53	24	0	26
Toyota	29		2	23	13	75	39	82	18	68	56	48	10	0	19
Honda	28		2	11	7	69	49	89	9	36	50	60	20	5	28
Nissan	23		4	29	17	16	24	37	27	34	28	60	13	5	26
Mazda	12		2	3	3	8	21	10	45	0	17	38	13	0	17
Suzuki	9		0	0	0	N/A	N/A	N/A	28	0	14	32	4	0	12

Tata Motors is the first automaker to transition from Laggard to Transitioner. In 2024, Tata continued introducing new EV models that diversified its offerings. Tata and subsidiary JLR also ramped up efforts in battery recycling and repurposing in major markets. **Hyundai-Kia**, which hovered on the Laggard-Transitioner threshold in past years, dropped to Laggard in this year's rating, partly because it has not disclosed progress in battery recycling and repurposing.

BYD surpassed co-leader Tesla in global BEV sales for the first time in 2024. BYD continued its expansion in the six major markets analyzed in this report and increased its BEV sales by 25% between 2023 and 2024; sales of BEVs and PHEVs combined grew by 47% over the same period. Like BYD, Tesla's overall score remained the same but its BEV sales stagnated from 2023 to 2024.

Figure 11 compares the 2023 and 2024 ratings of the 21 manufacturers.

Figure 11
Global Automaker Rating, 2023 versus 2024 scores



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Geely and Chery, both in the Transitioners group, showed the greatest improvement in final score compared with 2023. These automakers recorded substantial increases in ZEV-equivalent sales shares (of 13 and 10 percentage points, respectively) and expanded their product lines by adding new EV models. Both also shifted sales toward high-performing models that improved their fleet-average technology performance. Similarly, GM's introduction of new models, the Blazer EV and Equinox EV, raised its average ZEV performance scores and contributed to its total score increase.

Automakers based in Japan and the Republic of Korea continued to lag behind, but Honda and Nissan showed progress. Strong sales of Honda's first BEV model, the Prologue, in the United States resulted in substantial improvements across all BEV performance metrics. Honda also linked its executive compensation to CO_2 emissions for the first time. Nissan made substantial progress in ZEV ambition by separating its 40% by 2030 ZEV target from a previous target that included conventional hybrid vehicles.

Table 5 shows rating changes from 2023 to 2024 by automaker and metric.

Table 5

Comparison of overall and metric scores, 2024 versus 2023

OEM	2024 Overall			MARKET DOMINANCE				TECHNOLOGY PERFORMANCE									STRATEGIC VISION					
				ZEVe sales share		ZEV class coverage		Energy consumption		Charging speed		Driving range		Green Steel	Battery recycle/reuse		ZEV target		ZEV investment		Executive compensation	
Tesla	LEADERS	84	0	100	0	46	0	82	▼ 12	100	0	100	0	20	100	0	100	0	100	0	100	0
BYD		70	0	75	▼ 1	76	▼ 1	65	▼ 4	25	0	60	▼ 4	15	99	▼ 1	75	▼ 1	73	▲ 5	100	0
Geely	TRANSITIONERS	56	▲ 8	42	▲ 13	94	▲ 16	51	▲ 14	47	▲ 12	63	▲ 12	44	97	▼ 1	76	▼ 11	46	▲ 1	1	▼ 3
SAIC		53	▲ 2	47	▲ 7	100	0	61	▲ 5	14	▲ 1	29	▲ 3	16	84	▲ 1	71	▼ 2	63	▼ 2	0	0
BMW		52	▼ 5	19	▲ 2	54	▼ 1	70	▼ 3	51	▼ 3	87	▼ 3	78	84	▼ 9	68	▼ 16	18	▲ 1	52	▼ 8
Stellantis		52	▲ 3	8	▼ 1	70	▲ 2	33	▲ 2	29	▼ 2	38	▲ 3	25	97	▼ 2	100	0	19	▲ 12	100	0
Mercedes-Benz		51	▼ 1	14	▼ 1	52	▲ 2	49	▼ 1	44	▲ 1	84	▲ 2	100	91	▼ 2	89	▼ 1	42	0	12	▼ 3
VW		46	▼ 2	10	▼ 1	59	0	60	▼ 1	48	▼ 2	88	▲ 1	62	78	▼ 19	79	0	23	▲ 1	8	0
Chang'an		45	▲ 3	34	▲ 13	77	▼ 16	52	▲ 13	18	▲ 13	41	▲ 20	16	50	▼ 50	94	▲ 21	36	0	0	0
Chery		42	▲ 8	27	▲ 10	92	▲ 14	60	▲ 14	37	▲ 33	59	▲ 55	16	49	▼ 51	51	▼ 7	15	▼ 2	0	0
GM		40	▲ 3	6	▲ 2	17	▼ 2	75	▲ 16	51	▲ 22	94	▲ 19	53	82	▲ 8	89	▲ 2	9	▼ 1	15	▼ 40
Renault		39	0	9	▼ 1	72	▼ 2	49	▲ 8	21	▲ 6	36	▲ 9	25	93	▼ 2	66	▼ 18	11	0	17	▼ 7
Great Wall		38	▲ 3	26	▲ 9	47	▲ 1	39	▼ 7	25	▲ 7	49	▼ 4	16	99	▼ 1	88	▼ 1	6	▲ 3	0	0
Ford		35	▲ 1	5	▲ 1	30	0	15	▼ 8	48	0	85	▼ 1	72	79	▼ 13	60	▼ 19	11	0	11	0
Tata Motors		34	▲ 3	9	▲ 1	35	▲ 12	100	0	5	0	45	▲ 3	0	94	▲ 13	63	▼ 8	22	▲ 2	5	▲ 1
Hyundai-Kia	LAGGARDS	33	▼ 1	7	0	28	▼ 2	40	▲ 14	76	▼ 3	73	▲ 2	23	61	▼ 39	53	▼ 1	24	▲ 3	0	0
Toyota		29	▲ 1	2	0	23	▼ 5	75	▲ 4	39	▲ 7	82	0	18	68	▲ 9	48	0	10	▲ 1	0	0
Honda		28	▲ 8	2	▲ 1	11	▲ 5	69	▲ 34	49	▲ 23	89	▲ 35	9	36	▼ 6	60	▼ 7	20	▲ 1	5	▲ 5
Nissan		23	▲ 9	4	▼ 1	29	▲ 1	16	▼ 2	24	▲ 2	37	▲ 7	27	34	▲ 1	60	▲ 60	13	▲ 4	5	0
Mazda		12	▲ 4	2	0	3	0	8	▲ 8	21	▲ 2	10	▲ 8	45	0	0	38	0	13	▼ 2	0	0
Suzuki		9	▲ 5	0	0	0	0	N/A		N/A		N/A		28	0	0	32	0	4	0	0	0

Note: ▲ indicates score increase compared with 2023; ▼ indicates score decrease compared with 2023.

China-based automakers are ahead in ZEV market dominance. Geely, SAIC, Chang'an, Chery, and Great Wall increased ZEV-equivalent sales shares by 7–13 percentage points from 2023 to 2024 while other automakers made much more limited progress or recorded declines. Geely and SAIC reached 50% EV (BEV and PHEV) sales shares before applying our adjustment factors for PHEVs and both met their 50% EV by 2025 target 1 year ahead of schedule. That China-based automakers also make up the entire top 5 in ZEV class coverage suggests that a wider variety of offerings supports their higher EV sales. Besides Geely and Chery, Tata Motors and Honda were the only automakers to diversify their ZEV model offerings compared with 2023.

There was widespread improvement in ZEV performance. Most automakers scored higher on average ZEV performance, including ZEV energy consumption (16 out of 21 improved), charging speed (16 out of 21), and ZEV driving range (17 out of 21). These gains were underpinned by the introduction of new, high-performance ZEV models and market shifts toward more efficient, faster-charging, and longer-range ZEVs. For instance, GM and Honda introduced high-performance EV models in their limited EV offerings and it led to a big increase in their scores. Geely, Chang'an, and Chery, which already offered a diverse range of EV models, improved substantially with new high-performance EV lines or shifts toward premium brands.

Automakers that have made more effort to transition to renewable energy for manufacturing also received relatively higher scores on the new green steel metric. These include Mercedes-Benz, BMW, and VW. In addition, Ford and GM performed well in the green steel metric because of information disclosure regarding their existing efforts and long-term vision.[14]

Progress on strategic vision was relatively mixed. Nissan made progress by announcing a ZEV-only target. In addition, Chang'an and Hyundai-Kia slightly raised their ZEV targets while Ford, Tata Motors, Dacia (Renault), Mini (BMW), and Volvo Cars (Geely) rolled back or removed their ZEV targets. None of the 21 automakers significantly increased their ZEV investments in 2024. Furthermore, although Honda linked its executive compensation to a CO_2 emissions metric for the first time in 2024, GM removed EV development from the long-term incentives component of its executive compensation plan.

14 A counterfactual analysis using the 2023 renewable energy metric showed that strong performance on green steel led to a 4 point increase in the final scores for Ford and GM, and a 5 point increase for Suzuki. Most other automakers experienced moderate score increases of 1–2 points, while BMW and VW experienced decreases of 1–2 points. More details are in Table B8 in Appendix B.

7 DISCUSSION ON POLICY ALIGNMENT

7 DISCUSSION ON POLICY ALIGNMENT

How automakers engage with regulations provides additional context for how they are positioning themselves in the ZEV transition. Here we explore how well automakers are positioned to comply with key regulations in major markets, and how automakers work to influence those regulations through lobbying. Though not sufficiently quantitative to fit within the framework of this rating, these observations are important to consider when interpreting the rating.

7.1 Alignment with regulatory targets or national goals

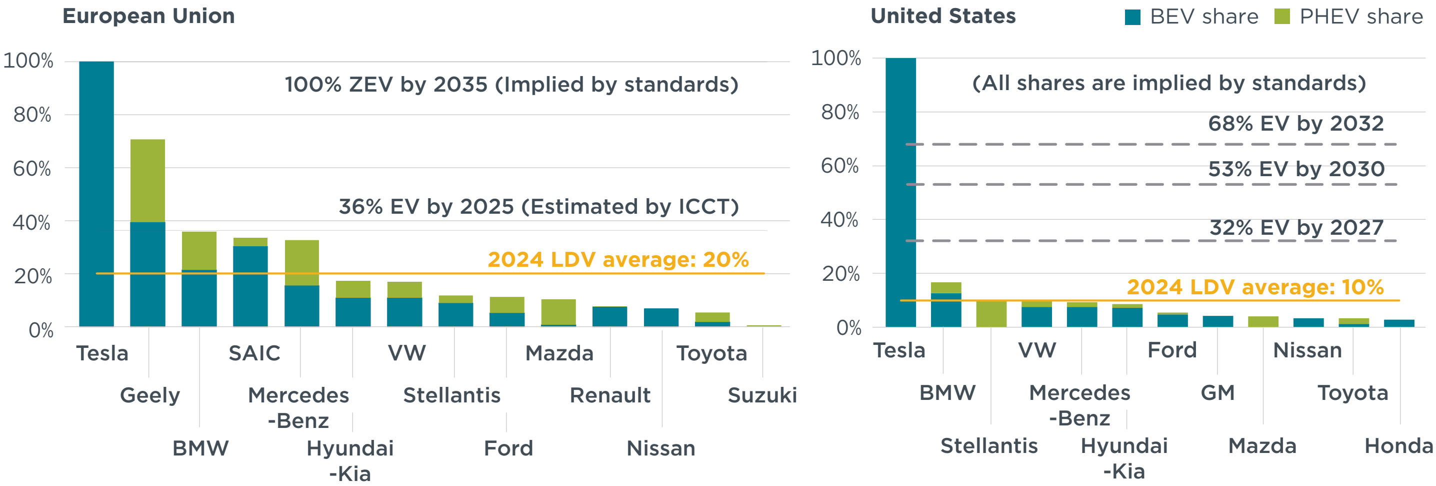
First and foremost, considering whether automakers are on track to meet regulatory targets tells us about their near-term position in the ZEV transition. Additionally, it highlights manufacturers that may not achieve regulatory targets and thus could have to pay other automakers to purchase their excess compliance credits or be subject to fines. Those over-complying with regulations that sell their excess credits generate additional revenue that could facilitate continued investment.

Here we show where manufacturers stand in terms of EV sales share compared with the estimated fleet-average EV sales shares needed to meet targets in a given region. Even though automakers can use a combination of advanced ICEV technologies and electrification to meet regulatory targets in the near term, progress in electrification will be necessary in the long term, especially when targets approach zero emissions, like the standards in Europe.

Figure 12 compares automakers' EV sales shares with the fleet-average EV sales share implied by regulatory requirements in the European Union and United States. Both markets have adopted stringent CO_2 or GHG emission standards for LDVs, and automakers are expected to largely use ZEVs to comply with them. The figure presents the 2024 EV market shares and distinguishes between BEVs (blue) and PHEVs (green); only automakers that accounted for more than 1% of new LDV sales in 2024 are included, and they are in descending order from left to right based on their 2024 EV share in each market.

Figure 12

2024 EV share by automaker versus implied targets in the European Union and United States

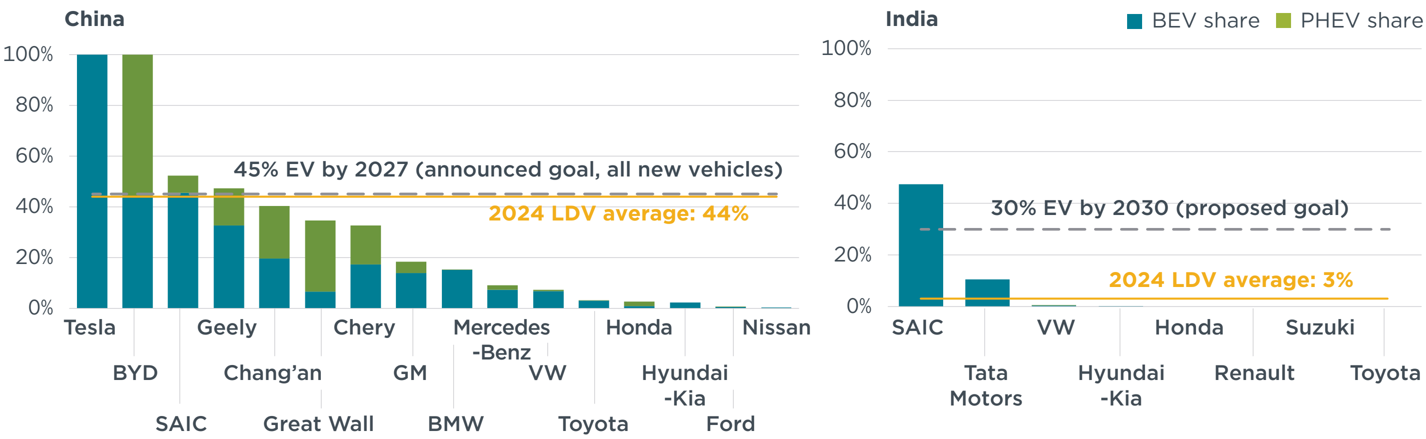


Regarding the EU CO_2 standards, the ICCT has estimated that an EV share of around 36% (28% BEV and 8% PHEV) will be needed to reach the 2025 CO_2 target if ICEV emissions remain the same and other flexible compliance mechanisms are not used (Dornoff, 2024). As of March 2025, prior to the approval of flexibilities that apply from 2025 to 2027, only three of the eight manufacturer pools had met or exceeded this estimated 2025 EV sales target.[15] BMW, Mercedes-Benz, and Geely subsidiaries Volvo Cars and Polestar are all part of these three pools (Monteforte & Diaz, 2025). Most other manufacturers still need considerable improvement to meet the 100% ZEV by 2035 target implied by the CO_2 standards.

In the United States, EPA finalized the Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles (2024) and they tighten GHG emission limits for LDVs. In EPA projections, the lowest-cost compliance pathway for automakers will be to sell, on average, 32% EVs (26% BEV and 6% PHEV) by 2027, 53% (44% BEV and 9% PHEV) by 2030, and 68% (56% BEV and 13% PHEV) by 2032. Focusing on 2027, Tesla has already surpassed the benchmark. BMW had above-average EV shares compared with the rest of the fleet in 2024 but will still need considerable EV sales share growth to stay on track to meet EPA's projections. Other manufacturers, including Ford, GM, Mazda, Nissan, Toyota, and Honda, were far from the 2027 benchmark in 2024.

China and India do not currently have regulations that push an EV sales share higher than the 2024 level. India has proposed more stringent fuel economy standards for LDVs, but they are not yet finalized, and China is still expected to introduce multi-pollutant standards for LDVs and LCVs. Given this, we use non-mandatory ZEV target announcements by the governments as benchmarks for comparison. These targets are shown in Figure 13, which presents the 2024 EV market share of the top automakers in terms of LDV sales in China and India and distinguishes between BEVs (blue) and PHEVs (green). As above, the figures only include automakers that accounted for more than 1% of new LDV sales in 2024 and automakers are in descending order from left to right based on their 2024 EV share in each market.

Figure 13
2024 EV share by automaker versus projected non-mandatory targets in China and India



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15 In the European Union, manufacturing pools allow car manufacturers to combine their vehicle fleets to collectively meet stricter CO_2 emission targets and avoid potential penalties.

In 2024, China announced a goal of 45% EV penetration in total vehicle sales by 2027 (State Council of the People's Republic of China, 2024). The LDV fleet in China is already on track to exceed that target, as 44% of LDVs sold in 2024 were EVs and 47% were EVs in the first quarter of 2025 (China Automobile Dealers Association, 2025). Among individual automakers, Tesla, BYD, SAIC, and Geely already reached or exceeded this 45% goal in 2024, while Chang'an, Great Wall, and Chery are nearing the target. Other automakers, most of them not domestic, fell further below the national average target.[16]

The Government of India has proposed a goal of 30% EV penetration in total vehicle sales by 2030 (Office of the Principal Scientific Adviser to the Government of India, n.d.) In 2024, SAIC already achieved the goal. Tata Motors will need to accelerate its EV adoption to be on track to meet the goal. The remaining manufacturers also have considerable ground to cover to reach the 30% goal on time.

7.2 Lobbying efforts

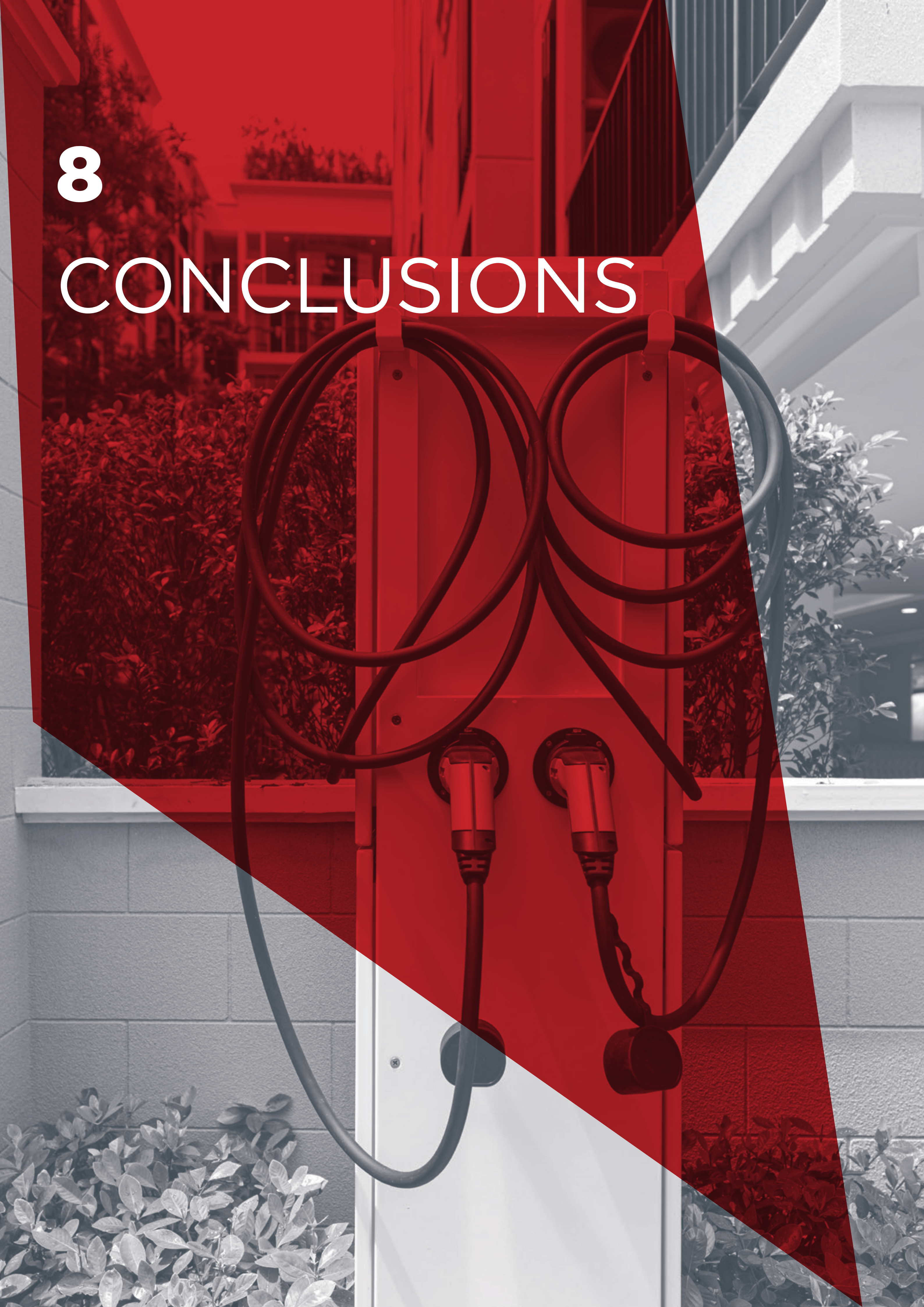
Automakers' lobbying efforts are another indication of their commitment to the ZEV transition. Most lobbying is done behind closed doors. Still, we can draw some inferences from public statements and from automaker ratings on InfluenceMap's (n.d.-a) LobbyMap, a database of lobbying on climate policy that covers all the manufacturers assessed in this report. InfluenceMap's rating ranges from A+ (broad support for climate policy) to F (increasingly obstructive behavior). More details are provided in Table B.7 in Appendix B.

None of the 21 automakers assessed in this report earned an "A" in InfluenceMap's most recent (February 2025) ranking and 11 had scores that ranged from D- to D+. Several of the China-based manufacturers (Geely, BYD, Chery, and SAIC) had higher scores, as did Ford and GM, which did better than other automakers assessed in part because of their support for EPA's GHG standards for LDVs (EPA, 2024; InfluenceMap, n.d.-b; InfluenceMap, n.d.-c). Although Ford's target of 100% ZEVs globally by 2035 is not the most ambitious among surveyed manufacturers, the company's support for stringent regulations suggests that it may be more serious about meeting its targets than others. Additionally, although Hyundai only targets a 36% ZEV sales share by 2030, its C- score from InfluenceMap is higher than many other automakers.

Meanwhile, Stellantis received a top score in our rating for its ZEV targets of 100% for PCs in the European Union and 50% for LDVs in the United States by 2030, but it was scored low by InfluenceMap after issuing a lukewarm statement on EPA's GHG standards (Stellantis, 2024, InfluenceMap, n.d.-d). Toyota ranks near the bottom of InfluenceMap's rating and InfluenceMap reported that Toyota opposed stricter vehicle emission standards and ZEV mandates in key markets, including the United States, Canada, and the United Kingdom, while also lobbying for weaker targets and reduced ZEV requirements. In 2023, Toyota stated its opposition to the then-proposed higher GHG emissions standards for LDVs in the United States (Toyota Motor North America, 2023).

16 For manufacturers headquartered outside of China that operate in China through joint ventures, only the sales of their globally available brands are included in the scope of this report. Sales of joint-venture brands created specifically for the Chinese market are excluded from their totals, though they may be reflected under the sales of the local Chinese partner.

8 CONCLUSIONS



8 CONCLUSIONS

Having rated the world's top 21 automakers in terms of ZEV market dominance, technology performance, and strategic vision, we close by highlighting the following conclusions:

1. **Tata Motors is the first automaker to transition from the Laggard group to the Transitioner group.** Tata improved its score by introducing new EV models and diversifying its EV offerings. Tata and subsidiary Jaguar Land Rover also ramped up efforts in battery recycling and repurposing in major markets. **Geely and Chery, both among the Transitioners, showed the largest increases in their final scores compared with 2023.** The improvements included big increases in ZEV-equivalent sales shares and offering new models that expanded the variety of their ZEV product lines. Additionally, both Geely and Chery shifted sales toward high-performing models that improved the average performance of their BEV fleets.

2. **BYD surpassed co-leader Tesla in global BEV sales for the first time in 2024.** From 2023 to 2024, BYD continued its expansion in the six major markets assessed in this report and recorded a 47% increase in its total BEV and PHEV sales; BEV sales alone grew by 25% year-over-year. Tesla's score remained the same but its BEV sales stagnated from 2023 to 2024.

3. **Automakers based in Japan and the Republic of Korea still lag, but Honda and Nissan showed progress.** Honda introduced its first BEV model, the Prologue, in the United States and its strong sales led to substantial improvement in all BEV performance metrics for the company. Nissan, meanwhile, strengthened its ZEV ambition by separating its 40% ZEVs by 2030 target from a previously announced electrified vehicle target that included conventional hybrid vehicles.

4. **China-based automakers are far ahead in ZEV market dominance.** Geely and SAIC reached 50% EV sales share (including BEV and PHEVs) before applying our adjustment factors for PHEVs, and thus both met their 50% EV by 2025 target 1 year ahead of the schedule. The top 5 in ZEV class coverage rating are all China-based automakers.

5. **There was widespread improvement in ZEV performance.** Most automakers scored higher on their average ZEV performance, including on the energy consumption metric (16 out of 21 increased scores), charging speed (16 out of 21), and driving range (17 out of 21). The key driving factors were the introduction of high-performance new ZEV models and a market shift toward ZEVs that are more efficient, charge faster, and have longer electric driving range.

6. **Automakers that showed more effort in transitioning to renewable energy for manufacturing in our previous ratings received relatively higher scores on the new green steel metric in this rating.** These include Mercedes-Benz, BMW, and VW. In addition, GM and Ford performed well on the green steel metric because of strong information disclosure on relevant efforts and vision.

Finally, while not part of the rating, we observe that most automakers will need to accelerate ZEV deployment to comply with key regulations in major markets. Only Tesla and several of the China-based manufacturers (BYD, Geely, and SAIC) are on track to meet or exceed the fleet-average EV sales shares implied by the regulations or government EV targets in regions including the United States and European Union.

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APPENDIX A. DATA PROCESSING AND SOURCES

We sourced information about the financial value of manufacturers' steel procurement relationships with suppliers from Bloomberg Financial data. Information about manufacturers' targets for and commitments to using green steel in manufacturing, battery recycling and repurposing, ZEV targets, ZEV investments, procurement agreements, and direct investments in battery raw materials and charging infrastructure were primarily sourced from their latest annual sustainability reports and announcements. Table A1 includes the complete list of annual sustainability reports and supplementary sources reviewed for this analysis.

Table A1

Manufacturer reports and public resources used in the rating

OEM	Sustainability reports	Other sources
BMW	2024 Annual Report	2024 BMW Group Remuneration Report
		2022 BMW's low-carbon steel goal for European plants
		2022 BMW's offtake agreements
		2022 BMW's MOU with HBIS Group
BYD	2024 BYD CSR Report	
Chang'an	2023 Semi-Annual Report	
Chery	2023 CSR Report	2023 MOU with Baosteel
Ford	2024 Integrated Sustainability and Financial Report	2025 Ford Motor Company Proxy Statement
		2022 Ford's First Movers Coalition commitment
		2022 Ford's MOU with Salzgitter, Tata Steel, and Thyssenkrupp
Geely	2024 Geely Group ESG Report	2021 Volvo Cars secures steel from SSAB
	2024 Volvo Car Annual Report	
		2024 Volvo Car Group Remuneration Report
GM	2023 Sustainability Report	2024 GM Proxy Statement
		2023 Sustainability Advocacy Report
		2022 GM's First Movers Coalition commitment
		2023 GM's supply agreement with ArcelorMittal
		2021 GM's supply agreement with Nucor
		2024 GM's supply agreement with U.S. Steel
Great Wall	2023 Corporate, Social, and Responsibility Report	
Honda	2024 ESG Data Book	2024 Honda Integrated report
		FY2024 Honda 20-F Form
Hyundai-Kia	2024 Sustainability Report (Hyundai)	
	2024 Sustainability Report (Kia)	
Mazda	2024 Sustainability Report	2024 Integrated Report
Mercedes-Benz	2024 Annual Report	2024 Remuneration System Report
		2023 Mercedes-Benz's CO2-reduced steel commitment
		2023 Mercedes-Benz's supply agreement with Steel Dynamics, Inc.
Nissan	2024 Sustainability Data Book	2024 Financial Information as of March 31, 2024
		2024 Nissan's The Arc Business Plan Press Release
Renault	2024 Climate Report	2024 Board of Directors' Release on Remuneration
	2024 URD Report	
SAIC	2023 Annual Report	
Stellantis	2024/2025 Climate Policy Report	2024 Remuneration Report
Suzuki	2024 Sustainability Data Book	2024 Integrated Report
Tata Motors	2023-24 Integrated Annual Report	
	2024 JLR Annual Report	
Tesla	2023 Impact Report	2024 10-K Form
Toyota	2024 Sustainability Data Book	2024 20-F Form
VW	2024 Annual Report	2024 Remuneration Report
		2022 VW's MOU with Salzgitter
		2023 Porsche's supply agreement with Stegra
		2024 VW's supply agreement with Vulcan Green Steel
		2024 VW's MOU with Thyssenkrupp
		2024 VW's EAF steel from Salzgitter

To assess the performance of the top 21 automakers in the ZEV transition, we created a database of all LDVs sold in 2024 by powertrain in six global markets: China, the United States, Europe, India, and Japan (the top 5 markets in terms of LDV sales in 2024) and the Republic of Korea (the 11th largest in sales and the sixth largest in terms of vehicle production). The database also included vehicle specifications of the EV models offered by the 21 automakers in 2024.

To maximize coverage and accuracy, we compiled vehicle data from multiple sources. Data on 2024 global vehicle sales by powertrain were derived from four sources: U.S., Korea, and Japan data were from MarkLines (n.d.); Europe data, including vehicle sales in the European Union, European Free Trade Association Member States, and the United Kingdom were from Dataforce (n.d.); India data were from Segment Y (n.d.); and China data were from Gasgoo (n.d.). For European and U.S. models, specification data (length, gross weight and curb weight, gross battery capacity, energy consumption, driving range, charging duration, and PHEV charge-depleting range) were collected from specification brochures on manufacturers' official websites and from major EV information hubs, including EV Database (n.d.), EV Specifications (n.d.), and EV Volumes (n.d.). The corresponding data for Chinese models were collected from Dongchedi (n.d.) and from brochures on manufacturers' official websites.

As this study centers on LDVs, LCVs were included in our analysis. To eliminate medium- and heavy-duty commercial vehicles from our database, we applied an upper threshold of 3,500 kg for non-U.S. LCVs and 3,856 kg for U.S. LCVs, because the definition of LCVs in the United States is a bit broader than it is in the other markets.

For joint ventures in China, where manufacturers not headquartered in China collaborate with a China-headquartered counterpart under a technology-sharing agreement, we distinguished vehicles by non-domestic or domestic brand and counted the sales toward the corresponding controlling corporate entity. For instance, although Buicks sold in China are produced by SAIC, we attributed their sales to GM because Buick is a GM brand and its models are mainly designed and determined by GM. This process involved various data sources. Table A2 lists the 21 manufacturers and their major brands.

To match the vehicle specification database with the EV sales database, we used model-level matching instead of variant-level matching; this is because sales information was not available at the variant level across all six regions. In cases where a model had multiple variants with different specifications (e.g., for battery size or range), we calculated the average of all variants to obtain the representative model specification.

Consistent with the last edition of this report, we applied a threshold for vehicle specification-related metrics (class coverage, energy consumption, charging speed, and driving range) that required sales of at least 100 units of a model in the six major markets.[17] Setting this threshold helped to exclude models that are produced at sub-commercial scale. The total sales of excluded models accounted for 0%–0.1% of the ZEV sales for each automaker, minimally impacting the sales-weighted average of BEV specification-related metrics.

17 For databases covering the global market, we applied the 100-unit threshold. For databases that focus on a specific region (e.g., Chinese insurance data for China and Segment Y for India), we applied a regional threshold of 50 units to filter out models with small sales volumes. The rationale behind the regional filter is that regional databases contain model names that cannot be matched with models from global databases. This is particularly true for LCV models in China, which were identified by Catalogue number instead of a model name.

Table A

List of top 21 manufacturers and major brands

OEM	Major brand
BMW	BMW, MINI, Rolls-Royce
BYD	BYD, Denza, Fangchengbao, Yangwang
Chang'an	Chang'an, Avatr, Deepal, Kaicene, Kuayue, Oushang, Qiyuan
Chery	Chery, Exeed, iCar, Jetour, Kaiyi/Cowin, Karry, Luxeed, Qijie, Qoros, ZX
Ford	Ford, Lincoln
Geely	Geely, Caocao, Geometry, LEVC, Livan, Lotus, LYNK & CO, Maple, Ouling, Polestar, Radar, Volvo Cars, Yuancheng, ZD, Zeekr
GM	GM, BrightDrop, Buick, Cadillac, Chevrolet, GMC, Hummer
Great Wall	Great Wall, Haval, Ora, Tank, Wey
Honda	Honda, Acura
Hyundai-Kia	Genesis, Hyundai, Kia
Mazda	Mazda
Mercedes-Benz	Mercedes-Benz, Mercedes-Maybach, Smart
Nissan	Nissan, Datsun, Infiniti
Renault	Renault, Alpine, Dacia, JMEV
SAIC	Baojun, Clever, IM Motors, Maxus, MG, R Auto, Roewe, Wuling (SAIC), Yuejin
Stellantis	Abarth, Alfa Romeo, Chrysler, Citroen, Dodge, DS, Fiat, Fukang, Jeep, Lancia, Maserati, Opel/Vauxhall, Peugeot, Ram
Suzuki	Suzuki, Maruti
Tata Motors	Tata, Jaguar, Land Rover
Tesla	Tesla
Toyota	Toyota, Daihatsu, Lexus
VW	Audi, Bentley, Bugatti, Cupra, Jetta, Lamborghini, MAN, Porsche, SEAT, Skoda, Volkswagen

APPENDIX B. SUPPLEMENTARY DATA FOR METRIC SCORING

B.1. ZEV-EQUIVALENT SALES SHARE

Table B1 compares the 2023 and 2024 scores for the ZEV-equivalent sales share metric for each automaker. It also details the ZEV-equivalent sales share of each manufacturer across the six major markets and shows their total ZEV and PHEV sales shares globally. The final score of the ZEV-equivalent sale share metric is calculated from the ZEV-equivalent share for each automaker and is shown in the rightmost column.

Table B1

ZEV-equivalent sales share by manufacturer and region and score comparison, 2023 versus 2024

	ZEV equivalent share [a]						Global				2023		
OEM	China	United States	Europe	India	Japan	Korea	ZEV	PHEV	ZEVe	2024 Score	ZEVe	Score	Score Changes
Tesla	100%	100%	100%			100%	100%	0%	100%	100	100%	100	0
BYD	75%		92%	100%*	100%*		45%	55%	75%	75	76%	76	-1
SAIC	49%		31%	47%	-		44%	6%	47%	47	40%	40	7
Geely	42%	23%	49%	28%*	21%*	23%*	33%	17%	42%	42	29%	29	13
Chang'an	34%						20%	21%	34%	34	21%	21	13
Chery	27%		8%*				17%	15%	27%	27	17%	17	10
Great Wall	25%		84%*				7%	28%	26%	26	17%	17	9
BMW	15%	14%	27%	8%	6%*	10%	17%	7%	19%	19	17%	17	2
Mercedes-Benz	8%	8%	22%	6%	8%*	7%*	11%	8%	14%	14	15%	15	-1
VW	7%	8%	14%*	0.4%	7%*	29%	10%	3%	10%	10	11%	11	-1
Tata Motors	0.1%*	2%*	11%	11%	4%*	1%*	8%	5%	9%	9	8%	8	1
Renault	100%*		8%	-	-	-	9%	0.2%	9%	9	10%	10	-1
Stellantis	6%	3%	11%	22%	6%	8%	7%	5%	8%	8	9%	9	-1
Hyundai-Kia	2%	8%	15%	0.1%	99%*	6%	7%	2%	7%	7	7%	7	0
GM	17%	4%	14%*		-	1%*	6%	1%	6%	6	4%	4	2
Ford	1%*	5%	7%		-	-	5%	2%	5%	5	4%	4	1
Nissan	0.4%*	3%	10%	-	7%		4%	0%	4%	4	5%	5	-1
Toyota	3%	2%	5%	-	0.7%	4%*	2%	2%	2%	2	2%	2	0
Honda	2*	3%*	13%	-	0.02%*	-	2%	1%	2%	2	1%	1	1
Mazda	3%	1%	5%		0.3%*		1%	4%	2%	2	2%	2	0
Suzuki			0.2%*	-	-		0%	0.1%	0.02%	0	0.03%	0	0

[a] Asterisks signify that the automaker's total ZEV-equivalent sales in the respective region were fewer than 5,000.

B.2. ENERGY CONSUMPTION

Table B2 compares the 2023 and 2024 scores for the energy consumption metric for each automaker. It also shows the sales-weighted average adjusted energy consumption before and after the adjustment by curb weight in 2023 and 2024. Automakers are ordered from top to bottom starting with the lowest sales-weighted average energy consumption for their 2024 BEV sales.

Table B2

Sales-weighted fleet-average energy consumption of BEVs by manufacturer and score comparison, 2023 versus 2024

	Average WLTP energy consumption (Wh/km)			Average WLTP energy consumption (Wh/km)				
OEM	2024 Original	2024 Adjusted	2024 score	2023 Original	2023 Ajusted (23 parameters)	2023 Adjusted (24 parameters)	2023 score	Score changes
Tata Motors	91	110	100	84	114	114	100	0
Tesla	133	120	82	128	117	118	94	-12
Toyota	132	125	75	139	130	131	71	4
GM	140	125	75	139	136	137	59	16
BMW	147	127	70	148	129	129	73	-3
Honda	152	128	69	146	150	150	35	34
BYD	123	131	65	124	131	131	69	-4
SAIC	104	133	61	110	138	139	56	5
Chery	122	134	60	106	144	144	46	14
VW	149	134	60	152	136	136	61	-1
Chang'an	120	138	52	120	148	148	39	13
Geely	139	139	51	149	149	150	37	14
Renault	123	140	49	124	146	147	41	8
Mercedes-Benz	160	141	49	161	141	142	50	-1
Hyundai-Kia	154	146	40	163	155	155	26	14
Great Wall	137	147	39	136	144	144	46	-7
Stellantis	136	150	33	141	152	153	31	2
Nissan	157	160	16	151	159	160	18	-2
Ford	190	161	15	186	156	157	23	-8
Mazda	165	165	8	169	169	170	0	8
Suzuki								

B.3. CHARGING SPEED

Table B3 compares 2023 and 2024 scores for the charging speed metric for each automaker. It also shows the sales-weighted average charging speed for each automaker for BEVs that do not support fast charging and BEVs that support fast charging, and the sales share of each BEV group for each automaker. The table additionally summarizes the sales-weighted average charging speed considering the maximum average charging speed of BEV models of each automaker and their final scores for this metric.

Table B3

Average charging speed by charging type and manufacturer and score comparison, 2023 versus 2024

OEM	Charger type		Market share (%)		2024 max avg (kW)	2024 score	2023 max avg (kW)	2023 score	Score changes
	Normal (kW)	Fast (kW)	Normal (kW)	Fast (kW)					
Tesla		176	0%	100%	176	100	172	100	0
Hyundai-Kia		138	0%	100%	138	76	139	79	-3
BMW		99	0%	100%	99	51	102	54	-3
GM		98	0%	100%	98	51	63	29	22
Honda		95	0%	100%	95	49	58	26	23
VW		94	0%	100%	94	48	95	50	-2
Ford		93	0%	100%	93	48	91	48	0
Geely	14	108	17%	83%	92	47	72	35	12
Mercedes-Benz	10	90	4%	96%	87	44	84	43	1
Toyota	1	80	0%	100%	80	39	68	32	7
Chery	14	76	0.2%	99.8%	76	37	24	4	33
Stellantis	6	71	13%	87%	63	29	66	31	-2
BYD	5	58	0%	100%	58	25	57	25	0
Great Wall		57	0%	100%	57	25	46	18	7
Nissan		56	0%	100%	56	24	51	22	2
Mazda		51	0%	100%	51	21	47	19	2
Renault	2	58	12%	88%	51	21	42	15	6
Chang'an	6	84	47%	53%	47	18	26	5	13
SAIC	8	57	34%	66%	40	14	38	13	1
Tata Motors	9	28	9%	91%	26	5	26	5	0
Suzuki									

B.4. DRIVING RANGE

Table B4

Driving range by manufacturer and score comparison, 2023 versus 2024

OEM	2024 driving range (km)	2024 score	2023 driving range (km)	2023 score	Score changes
Tesla	537	100	527	100	0
GM	517	94	445	75	19
Honda	500	89	376	54	35
VW	496	88	483	87	1
BMW	493	87	495	90	-3
Ford	485	85	481	86	-1
Mercedes-Benz	482	84	469	82	2
Toyota	475	82	467	82	0
Hyundai-Kia	444	73	432	71	2
Geely	411	63	367	51	12
BYD	400	60	407	64	-4
Chery	395	59	209	4	55
Great Wall	362	49	373	53	-4
Tata Motors	348	45	334	42	3
Chang'an	337	41	267	21	20
Stellantis	324	38	313	35	3
Nissan	322	37	296	30	7
Renault	319	36	284	27	9
SAIC	295	29	281	26	3
Mazda	229	10	203	2	8
Suzuki					

B.5. ZEV TARGET

Table B5

Announced EV sales targets and score comparison, 2023 versus 2024

OEM	Brand	Electric vehicle (EV) sales target					2024 score	2023 score	Score changes
		Region	EV sales	Vehicle category	Year	Type			
Tesla	All	Global	100%	PC+LCV	N/A	ZEV	100	100	0
Stellantis	All	Europe	100%	PC	2030	ZEV	100	100	0
		U.S.	50%	PC+LCV	2030	ZEV			
Chang'an	All	Global	75%	PC+LCV	2030	ZEV, PHEV	94	73	21
GM	All	U.S.	50%	PC+LCV	2030	ZEV	89	87	2
		Leading markets	100%	PC+LCV	2035	ZEV			
Mercedes-Benz	All	Leading markets	50%	PC+LCV	2030	ZEV, PHEV	89	90	-1
		Leading markets	100%	PC+LCV	2035	ZEV			
Great Wall	All	Global	80%	PC+LCV	2025	ZEV, PHEV	88	89	-1
VW	VW	Europe	80%	PC	2030	ZEV	79	79	0
	VW	U.S.	55%	PC+LCV	2030	ZEV			
	VW	China	50%	PC+LCV	2030	ZEV			
	Audi	Global (excl. China)	100%	PC+LCV	2033	ZEV			
	Škoda	Europe	70%	PC+LCV	2030	ZEV			
	Bentley	Global	100%	PC+LCV	2030	ZEV			
	Porsche	Global	80%	PC+LCV	2030	ZEV			
	Others	/	/	/	/	/			
Geely	Volvo Cars	Global	90%	PC+LCV	2030	ZEV, PHEV	76	87	-11
	Others	Global	50%	PC+LCV	2025	ZEV, PHEV			
BYD	BYD	China	100%	PC+LCV	N/A	ZEV, PHEV	75	76	-1
SAIC	All	Global	50%	PC+LCV	2025	ZEV, PHEV	71	73	-2
BMW	BMW	Global	50%	PC+LCV	2030	ZEV	68	84	-16
	Roll-Royce	Global	100%	PC+LCV	2030	ZEV			
Renault	Renault	Europe	100%	PC	2030	ZEV	66	84	-18
	Others	/	/	/	/	/			
Tata Motors	Tata Motors	Global	30%	LDV	2030	ZEV	63	71	-8
	Jaguar	Leading markets	100%	PC+LCV	2025	ZEV			
	Land Rover	Leading markets	60%	PC+LCV	2030	ZEV			
	Land Rover	Leading markets	100%	PC+LCV	2035	ZEV			
Honda	All	Global	40%	PC+LCV	2030	ZEV	60	67	-7
Nissan	All	Global	40%	PC+LCV	2030	ZEV	60	0	60
Ford	All	Leading markets	100%	PC+LCV	2035	ZEV	60	79	-19
Hyundai-Kia	Hyundai	Global	36%	PC+LCV	2030	ZEV	53	54	-1
	Kia	Global	38%	PC+LCV	2030	ZEV			
Chery	All	Global	40%	PC+LCV	2030	ZEV, PHEV	51	58	-7
Toyota	All	Global	32%	PC+LCV	2030	ZEV	48	48	0
Mazda	All	Global	25%	PC+LCV	2030	ZEV	38	38	0
Suzuki	All	Japan	20%	PC+LCV	2030	ZEV	32	32	0
	All	India	15%	PC+LCV	2030	ZEV			
	All	Europe	80%	PC+LCV	2030	ZEV			

B.6. ZEV INVESTMENT

Table B6

ZEV investment by manufacturer and score comparison, 2023 versus 2024

OEM	2024 total ZEV investment (2023 USD millions)	2024 sales (average of 2023 and 2022)	2024 investment per vehicle (2023 USD dollar)	ZEV multiplier	2023 investment per vehicle (2023 USD dollar)	2024 score	2023 score	Score changes
Tesla	53,585	1,419,058	3,776	1.00	3,740	100	100	0
BYD	70,813	1,931,848	2,751	0.75	2,535	73	68	5
SAIC	42,699	1,704,031	2,367	0.94	2,427	63	65	-2
Geely	40,431	1,928,348	1,758	0.84	1,677	46	45	1
Mercedes-Benz	44,111	2,069,915	1,586	0.74	1,567	42	42	0
Chang'an	24,323	1,470,563	1,374	0.83	1,348	36	36	0
Hyundai-Kia	54,950[a]	4,981,897	926	0.84	810	24	21	3
VW	75,396	6,791,310	892	0.80	842	23	22	1
Tata Motors	12,256[a]	1,013,955	828	0.69	756	22	20	2
Honda	27,078	3,152,406	760	0.89	734	20	19	1
Stellantis	44,926	4,304,433	723	0.69	264	19	7	12
BMW	18,166[a]	2,139,960	688	0.81	658	18	17	1
Chery	4,597	670,012	577	0.84	657	15	17	-2
Mazda	9,518	738,989	484	0.38	559	13	15	-2
Nissan	11,373	2,352,818	483	1.00	361	13	9	4
Ford	17,354	3,065,611	441	0.78	413	11	11	0
Renault	6,836	1,529,991	441	0.99	426	11	11	0
Toyota	38,819	7,238,100	377	0.70	359	10	9	1
GM	12,223	3,216,428	366	0.96	368	9	10	-1
Great Wall	3,126	913,424	252	0.74	123	6	3	3
Suzuki	13,100	2,481,829	160	0.30	160	4	4	0

[a] We assumed an equal split of the total investment when a manufacturer's commitment included other future technologies (e.g., autonomous driving technologies).

B.7. LOBBYMAP

InfluenceMap (n.d.-a) evaluates the lobbying power of companies based on two primary scores: an organization score, which measures direct lobbying alignment with Paris Agreement goals, and a relationship score, which assesses how closely the industry associations a company works with align with those goals. The final performance band is determined by combining the organization and relationship scores and ranges from A+ (broad support for climate policy) to F (increasingly obstructive behavior). The table below summarizes LobbyMap scores for the automakers included in this study. Chang'an received effectively no organization score due to its very limited engagement intensity.

Table B7

LobbyMap ratings for the 21 automakers

OEM	Performance band	OEM	Performance band
Tesla	B	**Renault**	D+
Geely	B-	**Nissan**	D+
BYD	C+	**BMW**	D+
Chery	C	**Honda**	D+
SAIC	C	**Stellantis**	D+
Ford	C	**Tata Motors**	D+
VW	C-	**Great Wall**	D+
GM	C-	**Suzuki**	D+
Mercedes-Benz	C-	**Mazda**	D
Hyundai	C-	**Toyota**	D
		Chang'an	D-

B.8. COUNTERFACTUAL ANALYSIS USING 2023 RENEWABLE ENERGY USAGE METRIC

Table B8

Counterfactual analysis: 2023 renewable energy in manufacturing versus 2024 green steel

OEM	Final score (with Renewable energy in manufacturing metric)	Final score (with Green steel metric)	Score difference
Tesla	83	84	1
BYD	69	70	1
Geely	54	56	2
SAIC	52	53	1
BMW	54	52	-2
Stellantis	50	52	2
Mercedes-Benz	51	51	0
VW	47	46	-1
Chang'an	44	45	1
Chery	41	42	1
GM	37	40	4
Renault	38	39	2
Great Wall	37	38	1
Ford	31	35	4
Tata Motors	34	34	0
Hyundai-Kia	32	33	1
Toyota	28	29	1
Honda	28	28	1
Nissan	21	23	2
Mazda	9	12	3
Suzuki	4	9	5

APPENDIX C. METHODOLOGY DETAILS

C.1. REAL-WORLD ELECTRIC DRIVE SHARE ESTIMATION

We estimated real-world electric drive share based on the equivalent all-electric range from the EV specification database that we compiled.

Plötz et al. (2022) and Isenstadt et al. (2022) developed the best-fit curves that reflect the relationship between the equivalent all-electric and real-world electric drive share in the European Union and the United States, respectively. Using the range data we compiled as inputs, these curves were the basis for our estimates of real-world electric drive share across all major markets except China. While our calculations for China previously followed this approach, we updated our methodology by adopting a 2025 utility factor (UF) curve—which represents the share of driving performed in charge-depleting mode—proposed by CATARC (2025). This UF better captures real-world driver behavior in China by accounting for key factors such as charging habits, driving mode selection, and longer PHEV ranges.

United States

To estimate the real-world electric drive share of PHEVs in United States, we used the function and parameters from Isenstadt et al. (2022) and applied Equation 2 to each PHEV model. The original function and its coefficients were established by EPA to determine a PHEV model's UF.

$$UF = 1 - \left[\exp\left(-\sum_{i=1}^{k}\left(\frac{CD}{ND}\right)^{i} C_i\right)\right] \qquad (2)$$

where:

- CD WLTP CD mode range in km
- ND Normalized distance (2,200 km for private or 9,100 km for company cars, estimated by Plötz et al. [2022])
- C_i weighting coefficient (summarized in Table C2)
- k number of coefficients

Using engine-off distance traveled data collected by vehicle on-board diagnostics systems in California-based vehicles, Isenstadt et al. (2022) revised the normalized distance (ND) to 985 miles, 2.5 times the default value of 399 miles from EPA, to better reflect the real-world electric drive share of U.S. PHEVs. The other coefficients are displayed in the table below.

Table C1
Electric drive share coefficients established by EPA

Coef (C_i)	1	2	3	4	5	6	7	8	9	10
Electric drive share for city or highway	13.1	-18.7	5.22	8.15	3.53	-1.34	-4.01	-3.9	-1.15	3.88

India, Japan, and Korea

We used the same revised parameters from Isenstadt et al. (2022) for India, Japan, and the Republic of Korea, as there is no recent study available on real-world electric drive share in these countries. In addition, much like in the United States, private cars make up a large share of all vehicles. This differs from Europe, where company-owned vehicles are more common.

Europe

Plötz et al. (2022) estimated parameters for the real-world electric drive share of PHEVs in Europe following the same functional form as in Equation 2, but revised the ND and estimated parameters separately for private cars and company cars. Specifically, the authors adjusted the ND to 2,200 km for private vehicles and 9,100 km for company vehicles—2.8 and 11.4 times higher than the European Commission's default value of 800 km specified under the Euro 6e regulation. According to their estimation, electric drive share is significantly lower for company cars. Because our data do not differentiate by ownership type, we assumed a 70:30 ratio between company and private cars for vehicles sold in the European Union (Krajinska, 2023). The weighting coefficients are summarized in Table C2.

Table C2
Electric drive share coefficients established by the European Commission

Coef (C_j)	1	2	3	4	5	6	7	8	9	10
Electric drive share for city or highway	26.3	-38.9	-631.05	5,964.8	-25,095	60,380	-87,517	75,514	-35,749	7,155

China

To estimate the real-world electric drive share of PHEVs in China, we used the function and parameters from the proposed 2025 UF curve in Amendment No. 1 to GB/T 19753—2021 (CATARC, 2025).

The updated curve incorporates several real-world factors to more accurately reflect actual PHEV usage in China and addresses limitations of previous UF curves based on idealized driving conditions. Specifically, it accounts for common behaviors of drivers in China such as the frequent use of power-priority driving modes, variations in charging habits due to early termination or limited infrastructure, and the longer all-electric ranges of newer PHEV models. The 2025 UF curve thus provides a more realistic estimate of electric drive share, as validated in an analysis of 40.6 million km of real-world driving data. The ND was updated to 1,000 km in the proposal and the weighting coefficients are summarized in Table C3.

Table C3
Electric drive share coefficients established by the CATARC 2025 proposal

Coef (C_j)	1	2	3	4	5	6	7	8	9	10
Electric drive share for city or highway	14.4	-50.38	102.13	-128.95	107.32	-61.05	24.17	-6.66	1.26	-0.15

With this update, most automakers saw an increase in their estimated real-world electric drive share in China, especially Chinese automakers, along with non-Chinese ones like GM and Honda. On average, the real-world electric drive share rose from 48% under the previous methodology to 59% with the revised approach.

Table C4

Changes in real-world electric drive share estimate for automakers' PHEVs sold in China

OEM	U.S. curve	China proposal	Difference
BMW	32%	32%	0%
BYD	44%	55%	11%
Chang'an	58%	67%	9%
Chery	56%	66%	10%
Ford	27%	27%	0%
GM	59%	68%	9%
Geely	46%	53%	7%
Great Wall	57%	67%	10%
Honda	43%	53%	10%
Hyundai-Kia	29%	29%	0%
Mazda	28%	29%	1%
Mercedes-Benz	36%	37%	1%
Renault	29%	29%	0%
SAIC	44%	55%	11%
Stellantis	30%	30%	0%
Suzuki	30%	30%	0%
Tata Motors	25%	25%	0%
Toyota	41%	41%	0%
VW	25%	26%	1%

C.2. CLASS COVERAGE CATEGORIZATION USING ICEV-EQUIVALENT CURB WEIGHT

We divided the ZEVs in the sales dataset into eight classes based on vehicle length for PCs and curb weight for LCVs. We used adjusted curb weight for LCV classification. BEVs tend to weigh more than equivalent ICEVs because of their batteries, and this can result in inaccurate categorization when directly mapping them into classes designed for ICEVs based on curb weight. To ensure accurate comparisons, we adjusted the curb weight of BEVs to their ICEV counterparts.

To make this adjustment, we selected BEV models in the LCV class that had a comparable ICEV counterpart. The counterparts were identified and matched based on similarities in vehicle dimensions and power. In total, we identified 14 such models (see Table C5). The ICEVs' curb weights ranged from 935 kg to 2,745 kg, and the BEVs' curb weights ranged from 1,240 kg to 3,127 kg. We calculated the ratio between each ICEV and its BEV counterpart, yielding an average of 0.83. This average ratio was used as an adjustment factor to estimate the ICEV-equivalent curb weight of each BEV model, which was found to be a reasonable estimation method for BEV models with a wide range of curb weights.

Table C5
Curb weight comparison between ICEVs and BEVs and ICEV-equivalent curb weights

OEM	ICEV		BEV		Ratio	ICEV-equivalent curb weight (kg)
	Model	Curb weight (kg)	Model	Curb weight (kg)		
Tata Motors	Ace Standard	9,35	Ace EV	1,240	0.75	1,030
Stellantis	Citroën Berlingo Van XL	1,540	Citroën e-Berlingo Van XL	1,881	0.82	1,562
Ford	E-Transit Cargo Van High Roof	2,745	E-Transit Cargo Van High Roof	2,800	0.98	2,325
Mercedes-Benz	Sprinter Van 170" WB High Roof	2,411	eSprinter Van	3,060	0.79	2,541
Ford	F-150 Platinum	2,363	F-150 lightning Platinum	3,127	0.76	2,597
Stellantis	Fiat Ducato Van 35 L3H2	2,150	Fiat E-Ducato Van 35 L3H2	2,865	0.75	2,379
Renault	Kangoo Standard	1,447	Kangoo EV Standard	1,707	0.85	1,418
VW	MAN TGE Standard	2,240	MAN eTGE Standard	2,518	0.89	2,091
Stellantis	Opel Combo Cargo L2H1	1,369	Opel Combo-e Cargo L2H1	1,707	0.80	1,418
Stellantis	Peugeot Partner Long	1,385	Peugeot e-Partner	1,632	0.85	1,355
Hyundai-Kia	Porter II	1,795	Porter II Electric	1,970	0.91	1,636
Toyota	Proace City Long Panel Van	1,618	Proace City Electric Long Panel Van	1,837	0.88	1,526
Average					**0.83**	

We classified PCs into five classes (mini/subcompact car, compact car, midsize car, large car, and SUV/MPV). We combined the mini passenger car and subcompact car classes to reflect model availability in the smaller passenger car segment. The length thresholds for PC classification were based on EV Volumes' global segment classification (EV Volumes, n.d.); LCVs are divided into three classes (small, medium, and large). Reference mass thresholds for LCV classification were based on EU N1 subclasses (Regulation (EC) No 715/2007, 2007). The detailed weight thresholds are listed in Table C5.

Table C6
ZEV class categorization

Fleet	Class	Standards: Length (m)	Source
PC	Mini/subcompact	0–4.1	Adapted from EV Volumes classification[a]
	Compact	4.1–4.6	
	Midsize	4.6–4.8	
	Large	4.8–	
	SUV/MPV		
Fleet	**Class**	**Standards: Reference mass[b] (kg)**	**Source**
LCV	Small	0–1,305	EU N1 subclasses
	Medium	1,305–1,760	
	Large	1,760–3,500/3,800[c]	

[a] From EV Volumes (n.d.).
[b] The reference mass is defined as the unladen vehicle mass increased by a uniform mass of 100 kg.
[c] The upper threshold is 3,500 kg for non-U.S. LCVs and 3,800 kg for U.S. LCVs due to differing regulatory categorizations in the United States.

C.3. ENERGY CONSUMPTION ADJUSTMENT

We adjusted the energy consumption of each BEV model to account for weight differences, which inherently affect vehicle energy consumption. To study the relationship between energy consumption and curb weight, we followed Equation 3 and performed a linear regression analysis, using all BEV models sold by the 21 manufacturers (537 models).

$$EC = \alpha + \beta \times \mathit{Curb\ weight} + \varepsilon \tag{3}$$

Here, α is a constant, ε is the error term, and β is the coefficient that estimates on average how much energy consumption will increase for every additional kilogram in curb weight. Our analysis shows that $\alpha=47.4$, $\beta=0.0519$ (significant at 0.001 level) with an R^2 of 0.47. This indicates that, on average, each kilogram increase in curb weight is correlated with a 0.0519 $Wh \cdot km^{-1}$ increase in energy consumption. This finding is similar to that of a previous study (Weiss et al., 2020), which investigated 218 electric passenger cars from China, Norway, and the United States and found a correlation of 0.06 $Wh \cdot km^{-1} \cdot kg^{-1}$.

C.4. CHARGER DEFINITIONS

We categorized chargers as either normal or fast using the criteria below.

Table C7

Charger type definitions

Type of charger	Power output	Time for charging	Current type
Normal charger	3 kW–7 kW	Slow charging: 7–16 hours (0%–100%)	Alternative current
	11 kW–22 kW	Intermediate charging: 2–4 hours (0%–100%)	Alternative current
Fast charger	50 kW–100 kW	Fast charging: 30–40 minutes (10%–80%)	Direct current
	100+ kW	Ultra fast	Direct current

Source: Adapted from European Court of Auditors (2021).

C.5. REGIONAL GROUPS FOR THE GREEN STEEL METRIC

Table C8

Regional groups for the green steel metric

Region	Country
North America	Canada, Mexico, Puerto Rico, United States
South America	Argentina, Brazil, Chile, Colombia, Peru, Venezuela, Uruguay
Europe	Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Türkiye, Ukraine, United Kingdom
North Africa	Algeria, Egypt, Libya, Morocco
Sub-Saharan Africa	Angola, Kenya, Mozambique, Namibia, Nigeria, South Africa
Middle East	Bahrain, Iran, Iraq, Israel, Kuwait, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates
Central Asia	Azerbaijan, Georgia, Kazakhstan, Uzbekistan
India and Pakistan	India, Pakistan
ASEAN	Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam
China	China
Japan and Republic of Korea	Japan, Republic of Korea
Pacific	Australia, New Zealand

C.6. GREEN STEEL TARGET

In the scoring for the green steel target factor, 2030 targets are expressed as a percentage of the automaker's estimated global steel use in 2024. If the target was for CO_2-reduced steel, the automaker received 0.5 points for that portion, whereas if the target was for near-zero emission steel, it received 1 point.

$$\text{Near zero-emission steel target \%} \times 1 + CO_2\text{-reduced steel target \%} \times 0.5 \qquad (4)$$

C.7. GREEN STEEL OFFTAKE AGREEMENTS

The steel offtake agreements scoring method first quantifies the volume of steel considered in MOUs, LOIs, and contracts as a proportion of total steel demand. If unspecified, we assigned a value of approximately 0.2% to the manufacturer, equivalent to half the value of the lowest known contract quantity: VW's 0.4% contract with H2 Green Steel. We then awarded 1 point for secured contracts, and 0.5 points for non-binding MOUs and LOIs.

$$\begin{gathered}\text{Known quantity contract \%} \times 1 + \text{known quantity MOU \%} \times 0.5 + \\ \text{unknown quantity contract 0.2\%} + \text{unknown quantity MOU 0.2\%} \times 0.5 \qquad (5)\end{gathered}$$

Table C9

Steel targets and offtake agreements used in green steel metric

OEM	Steel target (% of steel demand in 2024)		Offtake agreements	
	Near zero-emission	CO_2-reduced steel	Contracts	MOU or LOI
Mercedes-Benz	4.7% from contracts with Stegra and SDI	4.7% from the remainder of the 200,000-tonne "CO_2-reduced" commitment	1. 50,000 tonnes of "almost CO_2-free" steel with Stegra 2. 50,000 tonnes of "CO_2-reduced" steel with SDI, reclassified as near-zero emission 3. Arvedi 4. Nucor 5. Salzgitter	1. LOI with Thyssenkrupp 2. LOI with Salzgitter 3. LOI with voelstapine
BMW		20% overall, driven by BMW's plan to source 40% "low-carbon steel" for its plants in Europe, which accounted for 50% of BMW production in 2024	1. Salzgitter 2. Stegra 3. SDI 4. U.S. Steel	1. MOU with HBIS Group
Ford	10% of crude steel as "near zero emissions" by 2030			1. MOU with Salzgitter 2. MOU with Tata Steel 3. MOU with Thyssenkrupp
VW	0.5% from contract with Stegra	5% from MOU with Vulcan Green Steel and contract with Salzgitter	1. 50,000 tonnes of "almost CO_2-free" steel with Stegra 2. 74,000 tonnes of EAF steel with Salzgitter	1. MOU with Vulcan Green Steel for 300,000 tonnes of "low-carbon steel" 2. MOU with Salzgitter 3. MOU with Thyssenkrupp
GM	5% of crude steel as "near zero emissions" by 2030, driven by announcement for North America, which accounted for 54% of GM's production		1. ArcelorMittal 2. Nucor 3. U.S. Steel	
Geely		11% overall, driven by Volvo Car's 50% "low embodied carbon steel" by 2030 procurement commitment. Volvo Cars accounted for 23% of Geely's production in 2024.	1. SSAB	
Chery			1. Baosteel	

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